


FUNCTIONAL COMPARISONS BETWEEN FORMAL AND INFORMAL TOOLS
SAMPLED FROM THE NENANA AND THE DENALI ASSEMBLAGES OF THE DRY

CREEK SITE

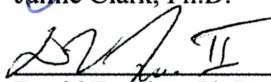
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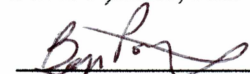
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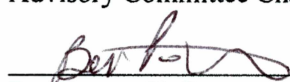
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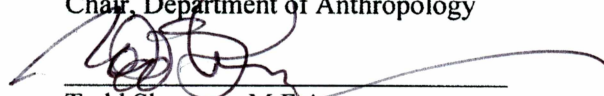


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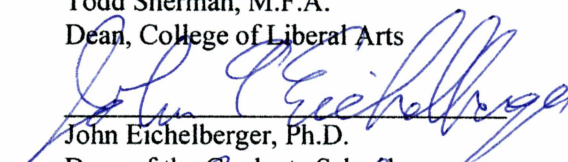


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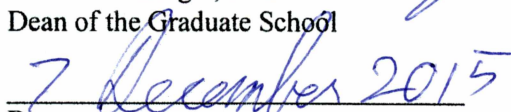
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FUNCTIONAL COMPARISONS BETWEEN FORMAL AND INFORMAL TOOLS
SAMPLED FROM THE NENANA AND THE DENALI ASSEMBLAGES OF THE DRY
CREEK SITE

A
THESIS

Presented to the Faculty
of the University of Alaska Fairbanks

in Partial Fulfillment of the Requirements

for the Degree of

MASTER OF ARTS

By

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Fairbanks, Alaska

December 2015

ABSTRACT

This research involved low powered microscopic analysis of usewear patterns on the utilized edges of formal and informal tools sampled from the Nenana component (C1) and the Denali component (C2) of the Dry Creek Site. Dry Creek is one of the type sites for the Nenana Complex, which is often contrasted with the Denali Complex in Late Pleistocene archaeological studies of central Alaska (12,000-10,000 B.P.). There are twice as many unifacial scrapers than bifacial tools in the C1 formal tool assemblage. The C1 worked lithic assemblage contains a relatively high number of unifacially worked endscrapers and side scrapers when compared to the number of bifacial knife and point technology. The technological makeup of the formal tools sampled from the Denali component is characterized by the manufacture and use of a higher number of bifacial knives and projectile points. The presence of microblades within C2 and the absence of microblades in C1 are often cited as the most significant technological difference between these two tool kits. The analysis presented here suggests that with or without microblades, the Nenana and Denali components are different tool kits. However, differences in utilization signatures between formal bifacial knives and scrapers tools indicate that technological variability within C1 and C2 at Dry Creek may largely be shaped by early hunting and butchering versus later stage butchering and processing activities.

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ACKNOWLEDGEMENTS

The past 15 years there have been many people that have influenced and guided my life practicing archaeology. I would like to thank my grandparents, Glenn and Thelma Aasland for flying me up to Alaska shortly after high school, which allowed me to explore the place and eventually call it home. I'd also like to point out many of the people I have worked with who have turned out to be much more than just coworkers. I'd like to thank my first crew chief, Scott Shirar for showing me how to work hard and get things done. I'd also like to thank my many friends and mentors who have crossed my path over the years, especially Chris and Audra Carlson, Lorena Edenfield, Tobias Holzlehner, Justin Hays, Molly Proue, Joshua Reuther, Carol Gelvin-Reymeiller, Hayley Brown, Jill Baxter McIntosh, Michael Wendt, Robert Bowman, Sarah McGowan, Jason Rogers, and Burr Neely. An especially big thank-you goes to my graduate advisor Dr. Ben Potter for expanding my interests in Alaskan prehistory. Thank you also to the rest of my committee members, Dr. Jamie Clark and Dr. David Fazzino. Last but not least, I'd like to acknowledge the staff working at the University of Alaska Museum of the North, as well as all of my parents, sisters, brother, nieces, nephews, and cousins in Michigan and Alaska, whom are too numerous to mention by name. I look forward to seeing everyone more, and skiing more, after this is completed.

CHAPTER I: INTRODUCTION

The Dry Creek Site was discovered in 1973 near the town of Healy, in the Nenana River Valley of central Alaska (Holmes 1974, 1975). The site was excavated in 1974, 1976, and 1977. The results of the excavation seasons produced 34,811 artifacts from three stratigraphically isolated cultural components. (Holmes 1974; Powers et al. 1983; Thorson and Hamilton 1977). A radiocarbon estimate of 11,120 B.P. for the lowest component at Dry Creek (C1) made it the earliest known site in Alaska at the time (Cook 1969; Powers et al. 1983; Powers and Hoffecker 1989; Thorson and Hamilton 1977; West 1967). The discovery of the Dry Creek Site inspired a significant expansion of the North Alaska Range Early Man Project, which sought to recover additional Pleistocene-era sites, thought to be hidden within the deep aeolian sediments that were deposited on glacial landforms within the north central Alaska Range (Hoffecker 1988; Powers and Hamilton 1978; Powers and Hoffecker 1989). The Dry Creek Site was declared a National Historic Landmark in 1978.

The Dry Creek Site is caught up in theoretical disputes that have led to ambiguities about the colonization of Alaska and the New World (Bever 2001; Buchannan and Collard 2008; Dixon 1985, 2001; Dumond 2001; Goebel et al. 1991; Goebel 2004; Hamilton and Goebel 1999; Hoffecker et al. 1993; Holmes 2001, 2011; Potter 2008a, 2008b; Powers et al. 1983; Powers and Hoffecker 1989; Straus et al. 2005). Excavations of the Nenana component (C1) and the overlying Denali component (C2) unearthed two different types of lithic tool kits. In C1, the tool assemblage was proposed to be more similar to non-microblade Paleoindian lithic traditions from the Plains of the U.S. than to known Denali complex sites in the region that have microblades. The C1 and C2 assemblages are also separated by approximately 1,000 years in time (Thorson and Hamilton 1977). The early age for the site and the absence of microblades within the C1 assemblage led some to hypothesize that an early Paleoindian population may have inhabited Alaska prior to the arrival of people from northeastern Siberia (Goebel et al. 1991; Hoffecker et al. 1993; Hoffecker 2001, 2005; Powers et al. 1983; Powers and Hoffecker 1989).

Over 60 years of formal tool analysis of terminal Pleistocene-aged sites has led to the description of six archaeological cultures within central Alaska near the end of the last Ice Age

(12,000-10,000 B.P.). These include: 1) the Denali Complex (West 1967, 1975, 1981); 2) the American Paleoarctic Tradition (Anderson 1968, 1970a; Dixon 1985); 3) the Chindadn Complex (Cook 1969; 1996, Yesner et al. 2011); 4) the Nenana Complex (Goebel et al. 1991; Powers and Hoffecker 1989); 5) the Mesa Complex (Hoffecker 2011; Kunz and Reanier 1994; 1995); and 6) the Dyuktai Complex (Holmes 2011).

Most analysis of the lithic tools from C1 and C2 of the Dry Creek Site has been formal, where tool function is assumed, versus demonstrated. Formal lithic tool analysis tends to focus on diagnostic tool types associated within a particular archaeological complex. Each complex is placed within one or more cultural historical models that have been developed for central Alaska (Cook 1969; Dixon 1985; Holmes 2001, 2011; Powers and Hoffecker 1989; West 1967, 1981). These models are compared with other regions in order to study past human migration patterns by tracing the diffusion of stylistically unique tool types from one area into another (Anderson 1968, 1970a; Bever 2006; Cook 1969; Dixon 1985; Goebel et al. 1991; Hoffecker 2011; Hoffecker et al. 1993; Kunz and Reanier 1994; Powers and Hoffecker 1989; West 1967, 1981). Assigning an archaeological site, or component, within a particular historical tradition is not always straightforward. For instance, James Dixon identified the Jay Creek Ridge Site as American Paleoarctic, Nenana, and Northern Paleoindian (Dixon 1985; 1999; 2001). Cultural Zone 4 (CZ4) at the Broken Mammoth site, the Little John Site, and C1 at Dry Creek have been described as either the belonging to the Chindadn complex, or the Nenana complex (Holmes 2011; Powers and Hoffecker 1989; Yesner 2001; Yesner et al. 2011). Both the American Paleoarctic Tradition and Dyuktai complex have been used to describe the cultural materials recovered from CZ4 at Swan Point (Hoffecker 2001; Holmes 2011).

There are also issues relating to the C1 and C2 artifact clusters within the Dry Creek Site (Figure 1). In 2006, Robert Thorson looked at the make-up and stratigraphic placement of the C1 and C2 artifact clusters and suggested that clusters X, Y, and Z from C1 are the result of post depositional downward movement of cultural materials from their corresponding clusters D, G, and J of C2 (Thorson 2006). Even though certain elements of C1 and C2 may be mixed, Thorson concluded that the cultural distinctions between Nenana and Denali technologies are correct, and that the date for C1 is also correct, though there may have been a third occupation in C1. This possible third occupation is younger than the tool industry with end scrapers (the

Nenana Complex) but older than the overlying microblade industry belonging to the Denali Complex and may have been contaminated by artifacts from the above Nenana component and bone from the Denali component. In a separate reevaluation of the C2 artifact clusters, John Hoffecker (2011) has suggested that clusters: E, K, and I of C2 should be reassigned to the Mesa Complex based on the age and styles of square and concave lanceolate projectile points, point fragments, and spurred graters indicative of Paleoindian populations. Hoffecker also hypothesized that there were at least three different cultural occupation times between C1 and C2 of the Dry Creek Site. The first period belonging to the Nenana Complex, second the Mesa Complex, which was followed by the Denali Complex (Hoffecker 2011). Hoffecker (2005, 2011) concluded that the Nenana Complex and Mesa Complex should be classified as cultural remnants of the Paleoindian Tradition of the North (Dixon 1999).

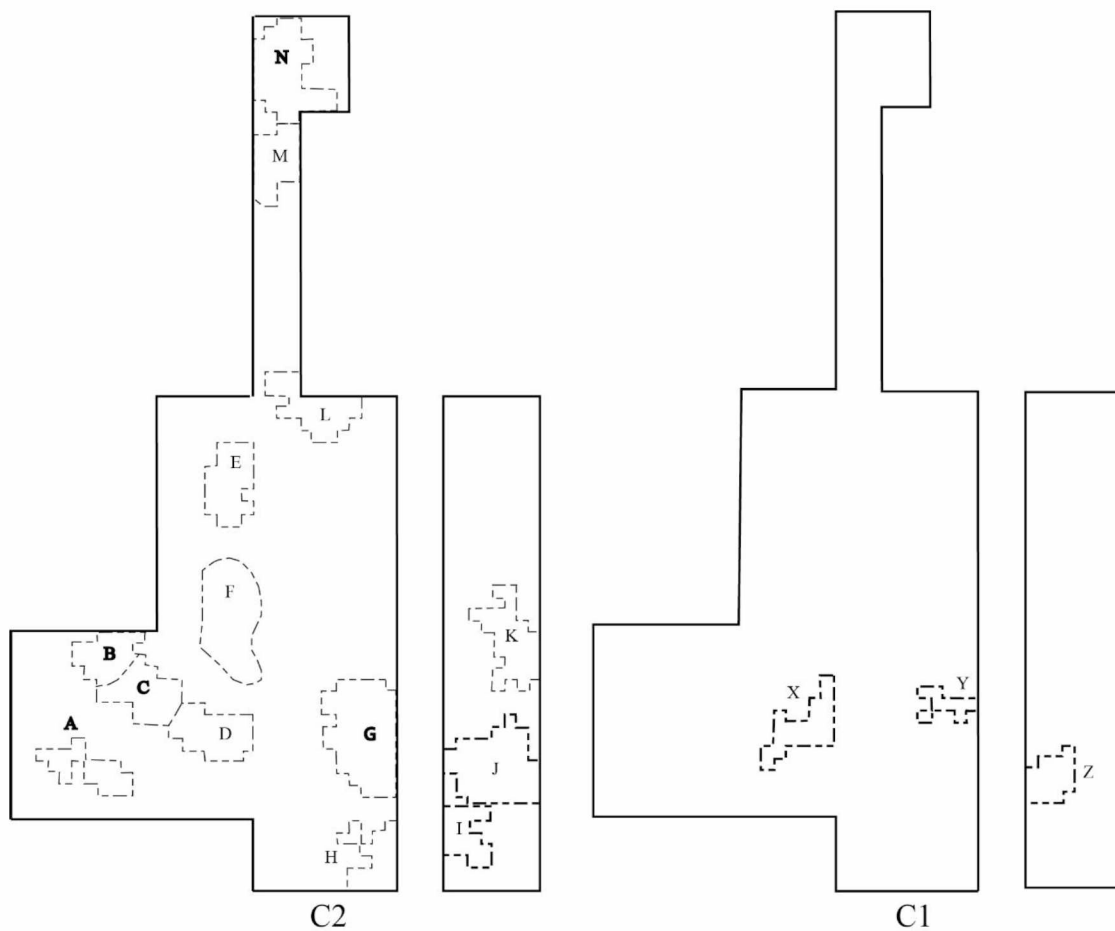


Figure 1. Artifact clusters of C1 and C2 of the Dry Creek Site (microblade clusters are in bold), adapted from Powers and Hoffecker (1989).

Given the limitations in applying purely formal methods, there are increasing calls for additional functional studies that go beyond normative constructs that tend to focus on describing the diffusion of diagnostic artifact types into particular areas. Correlating tool types with prehistoric human population movements is problematic given that tool kits can be shaped by additional factors such as human mobility, site function, site activities, climatic oscillations that alter the makeup and distribution of subsistence resources and having negative effects on the population, the season the site was settled, the availability and quality of lithic raw materials, as well as biased site sampling strategies and research methods (Bever 2001, 2006; Binford 1978; Binford and Binford 1966; Bousman 1993, 2005; Goebel 2011; Holmes 2001, 2011; Potter 2008a, 2008b; 2011; Potter et al. 2014; Shott 2010). Michael Shott argued that lithic tool types are the product of both adaptive function and history. Shott advocates combining formal and functional methods together, in order to improve archaeological theory and practice (Shott 2010). The work presented in this thesis is a hybrid study that combines low powered microscopic usewear analysis on formal and informal tool types sampled from the Nenana and Denali components of the Dry Creek Site.

At Dry Creek, bifacial tools are classified as projectile points, knives, scrapers, flake cores, and choppers (Powers et al. 1983; Hoffecker 1983). Formal attributes such as the manufacture technique, size, and shape of a tool does not always explain how a tool may have been used, if at all, prior to being discarded. Some tools may have more than one function, and it is necessary to consider the range of activities that each group of lithic tools from any archaeological assemblage may have been used for (Odell 2001).

Functional usewear analysis involves identifying and interpreting the activities associated with microscopic edge damage patterns and abrasional signatures that can form while the tool was in use. There are two prior usewear studies involving Denali and Nenana lithic tools. In 1980, Terry Del Bene published an article on microscopic edge damage patterns relating to microblade core reduction techniques in C2 at Dry Creek. Del Bene later compared the Denali assemblage to other microblade sites in Alaska in his Ph.D. dissertation, which emphasized the Anangula Core and Blade Site located on Ananiuliak Island in the Aleutian Chain (Del Bene 1982; Laughlin 1951). In 2002, Thomas Flannigan used low powered usewear analysis to identify artifacts from the Walker Road site that may have been overlooked as tools. Flannigan focused on miscellaneous artifacts, particularly flake tools.

Formal tools such as bifacial knives and scrapers were generally not included in either Del Bene's or Flannigan's analyses. This is the first functional usewear project comparing a Nenana Complex assemblage to a Denali Complex assemblage.

Hypothesis and Research Questions

Given that the Dry Creek Site contains both a Denali component and a Nenana component, with the former stratigraphically overlying the latter, there is a relatively rare opportunity to compare the activities involving remnant Nenana and Denali tool kits that were left at the same site. The main objective of this study is to compare how similar tool types sampled from C1 and C2 may have been used. Research was guided by four general hypotheses: (1) the C1 and C2 tools will exhibit similar types of utilization. (2) The C1 and C2 samples will have similar percentages of utilized tools; (3) formal tool types and functions between components are generally related; and (4) Dry Creek C1 and Walker Road (Flannigan 2002) usewear results are similar. In order to assess if the tool types were used in a similar manner, tool utilization was determined by answering four additional research questions: (1) what activities were conducted with each tool, prior to discard? (2) What materials were the tools used on? (3) Were any tools hafted? (4) How many tools, if any, are multifunctional?

The second hypothesis refers to the estimated number, or percentage, of utilized tools (versus non-utilized tools) for each sample. A tool was considered to be utilized if it exhibits microwear signatures on an isolated area of the tool, which is called a utilized element. The frequency of usewear on a tool assemblage is a partial indicator of how *intensely* the tools in each of the samples were used. How long, or often, a tool is used is a contributing factor to how well diagnostic microwear patterns will form on an edge. Generally speaking, the longer a tool is used, the more recognizable the presence of the microwear patterns will be (Bamforth 1988; Moss 1987).

How quickly utilization wear forms on the edge of a tool depends upon a number of factors such as: lithic raw material type, the total number of strokes completed, and whether the material worked was generally soft or hard (Bamforth 1988; Flannigan 2002; Moss 1987; Odell 1980). In one experimental study, tools used for durations of 5-15 minutes produced practically no identifiable microwear patterns (Fredericksen and Sewell 1991). If the intensity of activities, and materials worked, associated with formal and informal tools are similar between components,

then we may expect to see relatively equal percentages (or frequencies) of utilized tools in each sample. Hypothesis three, that formal tool types are functionally related is evaluated after comparing the frequency of usewear, the types of activities, and the materials worked associated with tools sampled from both components.

The Sample

The Nenana Complex is considered to be a non-microblade complex with a bifacial core and blade core industry associated with bifacial triangular knives, small triangular projectile points, lanceolate points, unifacial end scrapers on blades and flakes, side scrapers, burinated scrapers, blade-like flakes, retouched flakes, perforators, and wedges (Goebel et al. 1991; Powers et al. 1983; Powers and Hoffecker 1989). The Denali Complex is a bifacial core, blade, and microblade complex characterized by a variety of bifacial tools such as bi-convex knives, small projectile points, lanceolate points, endscrapers, side scrapers, wedge-shaped microblade cores, microblades, burins, burin spalls, and flake tools (Powers et al. 1983; Powers and Hoffecker 1989; West 1967, 1981).

The sample focused on formally worked bifacial and unifacial tools, blades, utilized flakes, retouched flakes, and burins that were previously reported from C1 and C2 of the Dry Creek Site (Powers et al. 1983). Large cobble tools, which were found in both components, were excluded from the sample, as were microblades, which are not comparable to C1. The purpose of focusing on the selected tool types is to compare the types of activities and materials associated with each particular tool type to order to highlight any potential functional similarities, or differences between the Nenana and the Denali worked lithic assemblages of the Dry Creek Site.

Component 1 Sample

There are 3,558 artifacts in C1; only 43 artifacts (~1% of the assemblage) were previously classified as tools; almost 99% of the C1 lithic assemblage is debitage (Powers et al. 1983). The C1 tool assemblage contains: 8 bifacial tools, 18 unifacial scrapers, and 17 miscellaneous artifacts (Powers et al. 1983). The total C1 bifacial tool assemblage was then subdivided into: 1 projectile point, 2 point bases, 1 biface base, 1 biface tip, and 3 bifacial knives (Powers et al. 1983).

Table 1. C1 tool types described by Powers et al. 1983.

<i>Bifacial Technology</i>	<i>Unifacial Scraper Technology</i>	<i>Miscellaneous Artifacts</i>
projectile points N=1	transverse scrapers N=3	quadrilateral uniface N=1
point bases N=2	side scrapers N=2	unshaped flake tools N=6
bifacial base N=1	end scrapers N=11	split cobble tools N=3
biface tip N=1	double end scraper N=1	cobble cores N=4
bifacial knives N=3	end scraper/burin N=1	anvil stones N=2
		split boulder N=1
Total: 8	Total: 18	Total: 17

The C1 sample included 29 tools, which is approximately 67 % of the tools described in Table 1. The C1 tool sample was meant to contain 100% of the bifacial tools and scrapers that were previously reported in Powers et al. (1983), however, only the projectile point, two point bases, two refit bifacial knives, a biface base, seven end scrapers, and a side scraper were available for this study. The missing tools could not be located during the time of the analysis. The split cobble tools, anvil stones, and split boulder, which are often reported in Nenana and Denali complex lithic assemblages, were left out of the sample (Goebel et al. 1991; Powers and Hoffecker 1989; West 1967, 1981).

The C1 tool sample includes a chalcedony burin (UA76-4135) that was previously reported in microblade cluster G, of C2 (Hoffecker 1983). The burin is located within the tray of C1 tools that are housed at the University of Alaska Museum (UAM), in Fairbanks Alaska. The UAM database also indicated that the burin was recovered from Loess 2 of C1. Loess 2 (L2) is the only stratigraphic unit for C1 at the site (Hoffecker et al. 1996; Powers and Hoffecker 1989; Thorson 2006; Thorson and Hamilton 1977). Loess 2 (C1) and loess 3 (C2) are vertically separated by a thin, relatively continuous layer of sand that may have originated during the Younger Dryas and is thought to represent a period of time between when C1 was abandoned and C2 was first occupied (Bigelow et al. 1990). Microblade cluster G, overlies cluster Y of C1 (Hoffecker 1983;

Powers et al. 1983). If Thorson's 2006 hypothesis is correct, then it is possible that the burin is intrusive from the microblade cluster in C2. Given that the burin is associated with C1 in the site database; and an atypical burin and burin spalls were recovered from the Walker Road Site (Powers and Hoffecker 1989); and a burinated scraper was reported in C1 at the Dry Creek Site (Powers et al. 1983); the chalcedony burin was included in the C1 sample in order to compare any similarities or differences in microwear signatures to burins that were sampled from C2.

Component 2 Sample

Dry Creek component 2 is composed of 28,881 stone artifacts, 2,124 (7.3%) of which are reported to be tools (Powers et al. 1983). The remaining 26,757 (92.7%) lithics are considered to be unutilized flakes (Powers et al. 1983). Based on Powers' classificatory framework, Dry Creek C2 has approximately eight formal and informal tool types that include: (1) wedge shaped microblade cores, microblades, and microblade byproducts, (2) burins, (3) projectile points, (4) knives, (5) heavy percussion flaked implements, (6) scrapers, (7) non-microblade core technology and (8) miscellaneous artifacts (Powers et al. 1983) (Table 2). There were 179 bifacial, unifacial, blade, and flake tools targeted for the C2 sample. The sample ended up containing 144 tools, or 80% of the targeted tool types. The difference in sample size between components was expected prior to initiating the study, given that the C2 lithic assemblage is roughly 12 times larger than the C1 assemblage (Powers et al. 1983).

Table 2. C2 Tool types and subtypes, originally classified by Powers et al. 1983

<i>Bifacial Tools</i>	<i>Scrapers</i>	<i>Projectile Points</i>	<i>Microblades & Byproducts</i>	<i>Burins & Byproducts</i>	<i>Cores (Other)</i>	<i>Heavy-flaked Instruments</i>	<i>Misc. Artifacts</i>
oblong knife N=1	transverse scrapers N=3	projectile point N=1	wedge shaped micro cores N=21	burins on a snap fracture N=10	subprismatic cores N=4	cobbles w/ lateral retouch N=7	hammer stones N=3
asymmetric triangular knife N=1	spokeshaves N=2	projectile bases N=6	aberrant microblade cores N=8	dihedral burins N=3	blade like flakes N=3	cobbles w/ retouch on end & side N=29	anvil stones N=3
small stemmed knives N= 8	side scrapers N=10	point tips N=2	wedge shaped core preforms N=3	angle burins N=2	blade like flake tools N=18	misc. cobble tools (bifacial) N=5	
elliptical knives N= 7	convergent-side scrapers N=6		miscarried core preforms N=21	transverse burins N=15	unshaped flake tools N=18	large flake tools (bifacial) N=7	
oval knives N=5	double side scrapers N=4		microblade core tablets N=45	core burins N=8			
ovate knives N=3			microblade by- products N=24	burin spalls N=35			
lanceolate bifaces N=2			microblades N=1772				
deltoid bifaces N=1			core scrapers N=21				
discoid bifaces N=1							
bifacial base fragments N=3							
bifacial tip fragments N=5							
biface midsection N=1							
misc. bifaces N=5							
Total	Total	Total	Total	Total	Total	Total	Total
43	25	9	1,918	63	43	48	6

Significance of the Results

In total, 173 formal and informal tools were sampled from C1 and C2 of the Dry Creek Site. This includes 29 tools from C1 and 144 tools from C2. Because lithic technologies are often the only culturally modified materials remaining in the early archaeological record of Alaska, stone tool technological industries too often serve as the only available proxy data to map human migration movements from one region to another (Bever 2006; Dixon 1999, 2001; Goebel et al. 1991; Goebel et al. 2008; Hoffecker 2011; Powers and Hoffecker 1989).

Normative archetypes are useful to compare and contrast different assemblages, but they may provide only a partial reason for the variability that is visible between Nenana Complex and Denali Complex tool kits. Given the relative success of previous functional usewear studies (e.g., Keely 1980; Keely and Newcomer 1977; Rots et al. 2006; Stevens et al. 2010; Tringham et al. 1974) there is potential to use this method to highlight potential functional variances within the C1 and C2 assemblages of the Dry Creek Site and generate hypotheses concerning how the Nenana complex and Denali complex tool kits may have been used in the past.

Although no single study will conclusively resolve the issues between the Nenana and Denali complexes, the problem can be addressed by focusing analysis on the range of activities that certain groups of formal and informal tools within each complex may have been used. There are a number of similar types of tools from both C1 and C2 at Dry Creek, from which comparisons of tool function is possible. The overriding problem in comparing the C1 and C2 assemblages is the fact that the C2 sample is much larger than the C1 sample. It should also be pointed out that the tool sample used for this project is essentially a biased sample in the sense that only certain predetermined tool types were selected for analysis.

CHAPTER II: RESEARCH DESIGN

In the mid-1970s, two different schools of thought emerged within the developing field of lithic usewear analysis. These two methodologies are often referred to as the *high powered* (Keeley 1980; Keeley and Newcomer 1977) and the *low powered* approaches (Odell 1975, 1977; 1980; 1985; Odell and Odell-Vereecken 1980; Tringham et al. 1974). The methods utilized for this project incorporated low powered techniques originally developed by Tringham et al. (1974); and largely popularized by George Odell (Odell 1977, 1980; Odell and Odell-Vereecken 1980).

Low powered microscopic analysis typically involves the use of binocular microscopes, with magnification ranges between 10x-100x (Odell and Odell-Vereecken 1980). In contrast, high powered analysts work with microscopes with magnification ranges between 100x-400x (Anderson 1980; Keeley 1980; Odell 1985). High magnifications up to 1,000x can occur with the use of electron microscopes (Evans and Donahue 2008; Stevens et al. 2010).

This project utilized a Nikon XMZ 1000 binocular microscope with magnifications between 8x-80x. It was found that utilized elements could easily be identified between magnifications of 8x-20x, while difficult areas with very small flake patterns were analyzed between 30x-60x. Low powered methods focus on microscopic edge damage, or flake scars, patterns such as hinge, step, feather, and snap fractures that form on the edges of tools during use. The utilized edge of the tool acts as a platform for flake detachment. When the tool edge makes contact with certain materials, the motion of the tool and the material that it is used upon acts as a percussor detaching different patterns of flake scars that reflect how a tool was used, and the resistance of the material worked (Odell 1980; Odell and Odell-Vereecken 1980; Tomenchuck 1997; Tringham et al. 1974).

Another form of diagnostic usewear that can form on utilized elements of a tool is *abrasional wear*. High powered analysts traditionally focused on abrasional wear patterns over microwear patterns to infer tool function and the types of materials that were used. Abrasional wear is harder to locate and is not always observable using low magnifications ranges. Abrasional wear includes: (1) *edge rounding* that develops the more an edge is used; (2)

striations that form in relation to tool motion; and (3) *polishes* that can form in relation to the material that was worked.

Both low powered and high powered methods are useful in identifying: (1) the utilized area of the tool that was used, (2) the motion of the tool, and (3) the kinds of materials the tool was last used upon (Evans and Macdonald 2011; Keely 1980; Odell 1980, 1988, 1994; Odell and Odell-Vereecken 1980; Pawlik and Thissen 2011; Semenov 1964; Shea 1988, 2008; Stevens et al. 2010; Tringham et al. 1974; Yerkes and Kardulias 1993). The particular area of the tool that was used is referred to as a *utilized element*. Utilized tools may have one or multiple utilized elements. The *activity* refers to the motion of which a tool was used, whether the tool was used for unidirectional scraping or cutting, bidirectional sawing, chopping, engraving, boring, or as a projectile. The *material worked* is harder to interpret using the methods employed (for reasons explained later); these were classified within a range of generally hard versus generally soft materials.

In order to evaluate the effectiveness of their methods, proponents of both the high powered and low powered schools executed several blind tests, using replicated stone tool sets, in order to measure the reliability of their methods. Experimental tool sets were used for various activities such as cutting, chopping, drilling, etc., on a variety of materials such as bone, antler, hide, meat, and wood by an independent party. These tools were given to a usewear analyst who was unfamiliar with how the tools were used. The analyst would then identify the area of the tool utilized, activity or motion of the tool, and the material each tool was used for.

After comparing the results of several independent low-powered and high powered experimental studies, Richards (1984) found that low-powered techniques are generally able to identify the area of the tool used 80% of the time, while the high powered approach was able to do this 88% of the time. Richards found that under the category of correctly identifying tool motion, the low powered approach was successful 70-75% of the time and the high powered approach was also successful approximately 75% of the time. However, when it comes to the identification of the exact material used, the high powered approach is more successful (62.5%), while the low powered approach is still only successful between 36-38% of the time (Richards 1984).

To improve the accuracy of identifying the material worked using low powered

methods, Odell and Odell-Vereecken (1980) tested and compared scales of specific material types and relative hardness of materials into blind tests. There are generally three categories of relative hardness: (1) *hard* (antler, bone); (2) *medium hard* (soft and hard wood) and (3) *soft* (plant, meat, hide) (Odell and Odell-Vereecken 1980; Tringham et al. 1974). Their results indicate that low powered techniques were successful in identifying the specific material only 38.7% of the time. However, the Odell's were more successful in identifying the relative hardness of the worked material around 61%-67% of the time, improving the accuracy of the low powered method (Odell and Odell-Vereecken 1980).

It was found that the Odells' success in identifying material hardness and tool motion depends on whether the tool edge is retouched before use or not. After performing blind tests on retouched tool, the Odells (1980) and Odell (1981) found that the location of wear was just as accurate as before. Reconstruction of tool movement, however, fell slightly to 60%, and identification of exact and relative hardness of the material was correct approximately 35% of the time. The identification of contact materials remains problematic. In a 2011 paper, Evans and Macdonald suggest that only 43% of published blind test results correctly identified that contact material that was worked.

In order to compensate for the limitations of low-powered techniques in identifying the materials that were worked, this study incorporated material hardness categories by dividing classes of materials into two broad groupings: medium-hard to hard, and soft to soft-hard. This subdivides the wear into two ranges of materials that can be thought of as being generally more resistant or yielding in nature. Further complicating the issue, a stone tool usually has to be used for a period long enough for recognizable wear patterns to develop, which can depend on the material of the tool, the hardness of the material worked, and the length of time the activity occurred (Vaughan 1985). Even if a tool were used on a very hard surface such as an antler, it would have to be utilized for a relative period of time in order for diagnostic edge damage patterns to develop on the utilized edge of the tool. In addition, it has been shown that not all tools in experimental and archaeological data sets exhibit usewear and it can be expected that only a certain percentage of artifacts in any archaeological component will exhibit these patterns (Odell and Cowan 1986; Shea 1988; Vaughan 1985).

There are benefits and drawbacks to both high powered and low powered methods. High powered techniques generally produce the greatest amount of data, and are more accurate in

identifying specific materials that tools were last used upon. The drawbacks of high powered techniques are that they are both more expensive and time consuming. Additionally, abrasional wear will not always form on experimental tool sets (Keeley and Newcomer 1977; Odell 1975, 1980). Low powered methods are cheaper and less time consuming, and are just as accurate in identifying tool use as high powered methods. The drawbacks are that specific materials types cannot be reliably inferred using low powered methods alone. A growing consensus is that the high and low powered approaches should not be viewed as competing approaches, but as alternative techniques that can be used to answer particular research questions (Odell 2001; Stevens et al. 2010).

The qualitative nature of usewear analysis leaves open the possibility of error, which can cause difficulties when attempting to compare assemblages analyzed by separate researchers (Macdonald 2014). A number of researchers have worked on quantitative approaches to usewear analysis by measuring surface topography, polish, and texture across utilized surface features, using high powered magnifications (Evans and Donahue 2008; Macdonald 2014; Stevens et al. 2010). The combination of high and low powered methods would provide a more holistic picture of each tool analyzed. However, given that high powered methods are very time consuming, low powered analysis is preferable for comparing functional aspects of multiple groups of tools sampled from Dry Creek.

Variables Considered

Both qualitative and quantitative data were used to record wear patterns upon the edges of utilized tools. Most of the data incorporated in usewear analyses are qualitative variables derived from experimental studies (Bamforth 1988; Odell and Odell-Vereecken 1980, van den Dries and van Gijn 1997). Variables such as the type and location of scar patterns, tool motion, and the resistance of the material worked, the type and location of abrasional damage, the presence or absence of sheen and oxidation patterns are all qualitative variables that vary in frequency between artifacts. Additional variables that were considered included flake size, tool length, tool thickness, and tool width. Tool and flake scar measurements were recorded in millimeters using digital calipers. The average edge angles of utilized edges were recorded with the use of a goniometer. Aside from edge damage patterns, this study also recorded abrasional wear signatures if they were discernible within 8x and 80x magnification ranges. Edge rounding,

polish location, and presence and orientation of striation patterns were recorded, if present, in association with microwear patterns along utilized elements of the tool edge. Additionally, secondary taphonomic signatures such as the presence or absence of surface sheen, oxidation, heat alteration, organic residues, trample damage, frost cracks were also noted.

Residues

This study also found that low powered methods are effective in identifying the presence of residues upon museum-curated tools. Multivariate approaches that incorporate usewear analysis with the analysis of residues from the natural and cultural environments upon the surfaces of stone tools is the latest emerging methodology to address hafting, tool function, and the specific materials that were worked (Anderson 1980; Hardy and Garufi 1998; Kealhofer et al. 1999; Wadley et al. 2004). Because microscopic fragments such as flesh, bone, blood, wood, hair, or plant fiber can become trapped within small cracks of on the tool surface the identification of these residues combined with usewear analysis may lead to even more reliable hypotheses concerning tool function, as well as highlight post depositional processes altering wear patterns (Anderson 1980; Cesaro and Lemorini 2012; Dinnis et al. 2009; Hardy and Garufi 1998). Differentiating between the cultural and natural environments is not always straightforward. In order to demonstrate that residues are culturally related, one would have to eliminate the possibility that the residues did not appear on the artifact in relation to the natural environment (Odell 2001).

Hafting Wear Patterns

A number of analysts have developed a combination of macroscopic and microscopic variables to identify where a tool may have been attached to a shaft, or handle (Dinnis et al. 2009; Keeley 1982; Odell 1994; Pawlik and Thissen 2011; Rots 2005; Rots et al. 2006; Rots et al. 2011; Rots and Plisson 2014). Rots et al. (2006) looked mainly for macroscopic scarring and retouch in hafted areas of tools along with occasional microscopic edge damage, polishes, striations, and edge rounding as indicators of where a tool was once hafted. Rots et al. (2006) also demonstrated that prehension from hand-held tools does not show an abrupt interruption of the usewear patterns, whereas hafted implements do.

Usewear Accrual Rates and Lithic Raw Materials

Differences in raw material types have been shown to affect the rate of use wear accrual in experimental studies. Certain lithic materials such as chert may develop diagnostic usewear signatures faster than other material types such as quartzite, both of which are common material types found in the Dry Creek collection. One experimental study by Greiser and Sheets (1977) attempted to characterize the attrition rates from use between quartz, limestone, chert, silicified sandstone, and obsidian by using a machine that could achieve a uniform speed, exert a uniform weight onto an object, and achieve uniform length of cuts in a replicable manner that is more precise than a human hand ever could. Each material was cut into wedges and placed into a machine and analysis was conducted after 10, 100, and 1,000 strokes. Interestingly, all of the materials exhibited significant wear after 1,000 strokes except for chert, which showed edge rounding and polish formation but relatively slight amounts of attrition (Greiser and Sheets 1977), implying that use wear on chert will form more slowly than on glassy obsidian or more granular lithic materials.

A separate experimental study in 2007 indicated that raw material hardness and micro topography (the relative roughness or smoothness of the surface) could influence the rate of use wear accrual (Lerner et al. 2007). Lerner's experimental study suggested that harder silicified wood might develop more invasive wear than softer cherts. The authors suggested that this is from the greater, more even surface area of the wood, which promotes the development of wear over materials with more irregularities on the surface (Lerner et al. 2007).

Though raw material type has been shown to influence the rate at which usewear accrues on a tool's edge, raw material properties have yet to be shown to influence the edge damage patterns and microabrasional structures that appear on utilized implements. Most experimental studies focus on a variety of European chalk flints, chert, basalt or obsidian, and the patterns of wear that form on these raw material types appear relatively similar. (Odell 1980; Odell and Odell-Vereecken 1980). For instance, in 1980, the Odell found that he was just as successful in identifying wear patterns on basalts, even though he had only worked with chalk flints (Odell and Odell-Vereecken 1980).

Secondary Modifications of Tools

The main problem with low powered methods lies in their inability to identify the exact material worked, especially if the utilized edge has been retouched. This is because methods that are more modern rely on the analysis of edge damage formation in combination with abrasional wear (Grace 1996). Potential errors arise in edge damage analysis if one cannot differentiate between retouch caused by utilization and retouch caused by secondary processes that are not related to the function and use of the tool. Secondary processes can mimic edge wear that resembles utilization wear, and they can be both cultural and natural.

Secondary cultural processes not related to the tool's use can mimic or completely obscure usewear on a tool as well. Keeley and Newcomer (1977) go on to argue that it is impossible to differentiate between a retouched edge and intentional tool use by edge damage alone. Cultural processes such as secondary retouch not related to tool use can mimic usewear patterns. Edge damage has also been shown to form on the edge of tools from spontaneous retouch that at times occurs during lithic reduction (Newcomer 1976). Spontaneous retouch may resemble deliberate retouch or false utilization on the blade of a stone tool. Spontaneous retouch forms when the force that functions to detach the flake away from the core. Once detached, the flake can sometimes act as a pivot point connecting the distal end of the flake to rotate briefly against the core, causing one to several microflake removals from the edge of the detached flake that can resemble retouch (Newcomer 1976).

Human or animal trampling of artifacts can cause edge damage on tools that are located above or just below the ground surface. At times human or animal trampling can mimic false utilization signatures, as well as erase clear signs of use on a tool altogether. Tringham et al. (1974) previously suggested that scar orientation from trampling is random and can be easily identified and accounted for, however they only experimented with 10 chert artifacts.

One previous experiment tested the combined effects of trampling and substrate to the formation of artificial retouch and utilization signatures on flakes (McBrearty et al. 1998). McBrearty et al. (1998) demonstrated that trample damage can occur to artifacts buried within either sand or loam matrices. The harder, more resistant surface of the loam may create more damage to tools than softer matrices such as sand. It was hypothesized that artifacts such as flakes that are buried within softer sediments can easily disperse beneath the subsurface limiting the amount of trample damage on the tool (McBrearty et al. 1998). One diagnostic characteristic

of trampling may come from the appearance of scuff marks (striations) on the eminent portions of a flake, such as the dorsal ridge or bulb of percussion (McBreaty et al. 1998). However, their results suggest there is no easy way to differentiate usewear from trample wear. McBreaty et al. (1998) also concluded that retouch formed on the dorsal and ventral surfaces of tools used in their experimental study and that flake scars formed by trampling are not always random, as previously suggested by Tringham et al. (1974), and that they can form perpendicular to the tool edge. This highlights potential obstacles in differentiating between primary modifications relating to tool use versus secondary modifications that relate to inadvertent human activities, the surrounding environment, and site formation.

Artificial edge and surface modifications of stone tools can also occur from secondary taphonomic processes such as solifluction, frost fracturing, forest fires, and mechanical and chemical erosion. Movement of artifacts within the soil can mimic traces of usewear as well as erase wear patterns on utilized surfaces (Burroni et al. 2002; Levi Sala 1986). Levi Sala (1986) shows that post depositional surface modification (PDSM) of flints and use polishes can make high powered techniques alone less reliable. Movement of artifacts through wet soils can erode striations, as well as form false ones not relating to tool use. Natural polishes or surface sheens are shown to develop in wet sandy loams and graveled rich matrixes at various rates (Burroni et al. 2002; Levi Sala 1986). Sala demonstrated that macroscopic sheen developed on the surfaces and edges of tools after they were moved within wet turbated sediments for an extended period. The effect of sheen developing on lithic surfaces can be enhanced if there is water and coarser grained material such as sand or gravel present within the matrix (Levi Sala 1986). Edge damage can also develop from the movement of artifacts through gravelly matrixes, which can also erode or reconfigure the distribution of microscopic edge damage patterns, as well as erase abrasional wear signatures such as striations along the utilized edge of a tool that can help identify tool motion (Del Bene 1979; Levi Sala 1986).

A separate experimental study reported by Burroni et al. (2002) theorized on the interaction between flakes and sediments as well. They found that the size of the grains that compose the matrix would increase the rate of wear on the surfaces of lithic materials, also the presence of moisture within the sediments acts as a lubricant that can trigger chemical reactions that promote the formation of films and false wear patterns. There is a sheen or gloss present on much of the material sampled from the Dry Creek collection. The sheen is visible around most

pronounced edges and raised surfaces of the tool. It frequently occurs on both the dorsal and ventral surfaces of the tool, and is easily differentiated from usewear polish as it occurs along all the edges of the tool versus a specific utilized area.

Two processes can take place as an artifact is churned through coarser grained wet sediments. Prominent surfaces can become smoother and more reflective of light (sheen), and the sharp edges of flakes can build up enough stress that may eventually crack and mimic retouch patterns on the edge. In addition, wet sandy or coarse grained matrices can also form striations on the edges and surfaces of a tool as an artifact if it is transported up or down the soil column (Burroni et al. 2002). No striations could be detected in relation to soil processes, though a higher resolution of analysis could yet detect such striations. However, the high percentage of sand within the sandy L2 and L3 matrices may have favored the formation of polishes as well as causing slight edge rounding, possibly erasing most patterns of abrasional wear on the tool collection.

Summary

The identification of abrasional wear in combination with edge damage patterns strengthens inferences related to which area of a tool was used, tool motion, and the material that was worked (Grace 1989; Stevens et al. 2010; van den Dries and van Gijn 1997). After the Uppsala Conference in 1989, a consensus has emerged concerning the relative merits of high and low powered methodologies (Grace 1996). Researchers no longer see themselves as being partial to one school of thought or the other. Instead, the high and low powered methods are seen as different alternatives that can be used in order to address a research question. It simply depends on what methods are best to answer the particular question at hand. Given the demonstrated ability of low powered methods in identifying the area of the tool used, and tool motion, these techniques are suitable for comparing how tools sampled from the Nenana and Denali components of Dry Creek may have functioned.

CHAPTER III: SITE SETTING

As mentioned in the first chapter, the high level of archaeological variability uncovered within the study area for the late Pleistocene to early Holocene period (12,000-10,000 B.P.) has resulted in the construction of several cultural historical frameworks that have been used to trace the origins and functions of prehistoric stone tool kits (Goebel 2011; Goebel et al. 1996; Holmes 2011; Potter 2011; Yesner et al. 2011). Over 50 years of research has led to the identification of several archaeological complexes or “cultures” that were (at one time or another) hypothesized to represent the earliest human inhabitants of Alaska (Cook 1969; Dixon 1985; Goebel et al. 1991; Holmes et al. 1996; Powers and Hoffecker 1989; West 1967; 1981).

In the Nenana and Tanana River Valleys, there are several well-excavated terminal Pleistocene archaeological sites that have revealed high concentrations of lithic tools. These are usually classified as belonging to either the Denali Complex (West 1967, 1975, 1981) the Chindadn Complex (Cook 1969, 1996) the Nenana Complex (Goebel et al. 1991; Powers and Hoffecker 1989), the American Paleoarctic Tradition (Anderson 1970a; Dixon 1985); the Northern Paleoindian Tradition (Hoffecker 2005, 2011); or the Dyuktai Complex (Holmes 2011).

In order to account for the high amount of technological variability reflected by these sites, a number of chronological models have been introduced that attempt to place each of the previously mentioned cultural constructs into a particular temporal and geographic framework that can be compared to cultural chronologies developed in other regions of Alaska, as well as the world. The creation and order of these models has led to a spirited debate revolving around the usefulness of classifying archaeological assemblages with the assumption that lithic variability is shaped by normative templates that have been trained in the mind of the tool maker (Holmes 2001; Hoffecker 2001; Pearson 1999; Potter 2008a, 2011, Potter et al. 2014; Thorson 2006; West 1975, 1981; Yesner 2001, Yesner et al. 2011).

The use of cultural chronologies is partially rooted in the desire to discover the travel routes of the earliest human colonizers of North America and the origins of Clovis “Paleoindian” populations in Alaska (Bever 2001; Goebel 2004; Muller-Beck 1967). This began to happen roughly a decade after the discovery of fluted Folsom projectile points in

association with extinct Pleistocene megafauna at Folsom, New Mexico in 1927 (Bever 2001; Cook 1927; Figgins 1927). With this discovery came the first irrefutable evidence that humans had lived on the North American Continent during the Pleistocene. Research projects followed to identify the prehistoric travel routes of the progenitors of Clovis populations from northeast Asia into North America by way of the Bering Land Bridge during the last Ice Age (Haynes 1982). Central Alaska was situated within eastern Beringia during the last Ice Age; given Alaska's strategic location for human entry into North America and down into the southern hemisphere, various surveys have been conducted within the Tanana and Nenana river valleys for Pleistocene human settlements that may also be ancestral to Clovis (Bever 2001; Hoffecker 1988).

The Dry Creek Site

The Dry Creek Site is located on a southeast facing terrace overlooking a wide open relict creek bed that is seasonally active and dry for most of the year. The site is located just outside the town of Healy, in the valley of Alaska's Nenana River. The site was discovered in 1973 by Charles E. Holmes (1974) who uncovered microblades in association with a hearth dating to approximately 10,690 B.P., indicating a near-terminal Pleistocene human occupation in the Nenana River Valley.

Excavations at Dry Creek in 1974, 1976, and 1977 identified three stratigraphically isolated components buried within 2.0 m of sediments containing multiple intervening soil horizons (Powers et al. 1983; Thorson and Hamilton 1977). With a conventional date of 11,120 B.P. from C1, the Dry Creek Site provided the first evidence of human occupation in the North Central Alaska Range for the late Pleistocene (Hoffecker 1988). Prior to this discovery, the oldest known site in central Alaska was the Chindadn Complex type site at Healy Lake (Cook 1969).

In 1994, Nancy Bigelow and Roger Powers returned to Dry Creek to collect additional radiocarbon dates for the Nenana component 1 (C1) and the Denali component 2 (C2), however no new formal lithics were collected (Bigelow and Powers 1994). The Dry Creek Site was re-excavated in 2010 and 2011 by Kelly Graf of Texas A & M as part of a two year field school program; the official results of these excavations are not yet public.

Site Structure and Stratigraphy

There are three components (C1, CII, and CIV) of the Dry Creek Site. Component 1 (11,120 B.P.) is associated with the Nenana Complex; C2 (10,600-10,000 B.P.) the Denali Complex; and C4 (2,430-4,670 B.P.) the Northern Archaic Tradition (Hoffecker et al. 1996; Powers et al. 1983; Powers and Hoffecker 1989). There was an additional component identified in 1974 but it was later determined to be an upper representation of C2 (Powers et al. 1983).

The components of the Dry Creek Site were encased within 2.1 m of sedimentary deposits that cap Healy I outwash cobbles (Thorson and Hamilton 1977). The stratigraphic column at Dry Creek suggests five periods of soil development, interbedded between seven loess units and four sand units. The tools sampled from the Nenana and the Denali components for this study were uncovered within one of four sedimentary units and two discontinuous paleosol layers. Component 1 is associated with loess 2 (L2) only. C2 was defined in loess 3 and 4 (L3, L4) and paleosol 1 and 2 (P1 and P2). P1 and P2 provided the bulk of the reported radiocarbon dates for C2 of the Dry Creek Site. There were no paleosol formations or hearths in L2 (C1); the only published date for this component comes from a single piece of charcoal located near a cluster of artifacts.

The Dry Creek C1 and C2 loess horizons are virtually identical to one another in both color and texture (Thorson and Hamilton 1977). L2 and L3 are separated by a thin discontinuous layer of coarse sand. The sand layer (S1) originated during the Younger Dryas, possibly as the result of increased wind activity from strong katabatic winds blowing down from advancing glaciers somewhere between 11,000 to 10,600 B.P. (Bigelow et al. 1990; Bigelow and Edwards 2001). Loess 3 of C2 is also distinguished from L2 by two relatively continuous paleosol formations believed to indicate immature tundra soils (Thorson and Hamilton 1977).

C1 and C2 Artifact Clusters

When one compares the C1 and C2 Dry Creek tool kits, one major difference is the absence of microblade materials in C1 and the presence of microblades in C2. C2, however, contains five microblade clusters and nine non-microblade clusters (Hoffecker 1983; Thorson 2006). Each artifact cluster was defined by a group of several excavation quads that unearthed

more than 20 artifacts per quad (Powers et al. 1983). There are three artifact clusters in the Nenana component (X, Y, and Z) and 14 artifact clusters in the Denali component. As previously mentioned, five microblade clusters (A, B, C, G, and N) and nine non-microblade clusters (D, E, F, H, I, J, K, L and M) were defined in C2 (Hoffecker 1983). The appearance of microblade and non-microblade clusters was also observed by Potter (2008a, 2011) who illustrated that at well-sampled sites like Dry Creek and Gerstle River, microblade related materials tended to cluster in discrete activity areas in association with non-microblade clusters.

Local Geology

An understanding of certain aspects of local geology and the placement of the Dry Creek site within an environment highly affected by advancing and retreating glacial activity provides a sense of the secondary processes that also may have impacted usewear signatures on the lithic tool collection. The Dry Creek terrace sits at the edge of a glacial outwash fan left by the Healy 1 glaciation that dates to Illinoian or Early Wisconsinian in time (Ritter 1982; Ritter and Ten Brink 1986; Thorson and Hamilton 1977; Wahrhaftig 1958). The Healy outwash is a 25 m thick layer of rounded to subrounded cobbles and small boulders (Thorson and Hamilton 1977). The Healy outwash matrix is primarily composed of clasts of quartz and schist, with minor amounts of metasediments and volcanics and would not provide a quality source of lithic material though quartz and quartzite tools are common at the site (Powers et al. 1983; Thorson and Hamilton 1977). Another close source of lithic raw material would be from the Dry Creek alluvium itself, which is approximately similar to Healy age outwash. At one time, Dry Creek drained in front of the Healy Glacier, picking up additional alluvium providing another source of lithic raw material near the site.

The lithology of the Dry Creek bed is estimated to contain 80% irregularly shaped cobbles and small boulders of quartz-mica schist and 20% well-rounded igneous and metasedimentary cobbles (Thorson and Hamilton 1977:151). Lithic material may also been harvested from the Nenana Bed, approximately 2 km west of the site location. The Nenana lode contains various assortments of volcanic and plutonic rocks mixed with a high amount of lithic sandstone and conglomerate, and quartz mica schist (Thorson and Hamilton 1977:151).

Prior to the deposition of the sediments which formed the Dry Creek terrace, the Healy

I age outwash gravel and cobbles at the site remained exposed for a period of time subjecting the surfaces to a variety of mechanical and chemical weathering processes, while other outwash cobbles within the Nenana drainage were immediately covered by alluvial fans, effectively protecting them from environmental alterations (Ritter and Ten Brink 1986).

Areas of Healy I age outwash near the Dry Creek bluff were subjected to wind abrasion, frost shattering, oxidation, and carbonate weathering (Thorson and Hamilton 1977:173). Thorson and Hamilton (1977) also noted that Healy I age outwash could be differentiated from Riley Creek age outwash according to environmental modifications. Healy age outwash cobbles consists of abundant fractures, wind polish, and ventifacts but lacks frost shattering and wind abrasion. Healy age alluvium is also characterized by heavy oxide staining and carbonates encrustations (Thorson and Hamilton 1977:172).

The Denali Complex

The type sites for the Denali Complex were first discovered in the Tanana River Valley at Donnelly Ridge (West 1967, 1981) and the Campus Site (Nelson 1935, 1937), followed by the Teklanika East, and Teklanika West sites of the Nenana Valley (West 1965, 1967). The Denali Complex type components revealed

a stone tool kit that favored bifacial biconvex knives, flat-topped end scrapers with graver spurs, large blades and blade-like flakes, wedge-shaped microblade cores, core tablets, microblades, burins on small flakes, and burin spalls (West 1967).

West (1967) originally hypothesized that the Denali Complex artifacts were left by an early cultural group that entered Alaska prior to the submergence of the Bering Land Bridge approximately 10,000 to 11,000 years ago (Hopkins 1967). However, proving that the Denali Complex actually did date to the terminal Pleistocene period was somewhat problematic (West 1967). Almost a decade after West first reported on the Denali Complex, all of the known Denali Complex sites had only been radiocarbon dated to the mid-Holocene at the latest, not the terminal Pleistocene. The radiocarbon dates for the Donnelly Ridge Site came from terrestrial charcoal samples since there were no hearths or bone samples for him to date. Given that the radiocarbon samples were terrestrial in nature, West inferred that the mid Holocene date was not associated with the cultural material at the site and that the actual age of the site may have been much older (West 1967).

The Denali component from the Campus Site was originally thought to date between 9,000-12,000 years old (Nelson 1935). This estimate was based on stylistic similarities between microblades and microblade cores recovered from Asia called premature conical or Gobi cores (Nelson 1935). West (1967, 1981) later classified them as wedge-shaped microblade cores since they are not truly conical. Though much later, a series of radiocarbon dates collected from the Campus Site suggested a mid-Holocene occupation of the Denali Complex there as well (Mobley 1991; Pearson and Powers 2001).

The Teklanika West Site was originally assumed to contain two components, the primary one being West's (1967) Denali Complex component. This component also remained undated for an extended period of time (West, 1967, 1974). After West's 1967 paper was published, radiocarbon estimates of paleosol A1b located above the Denali component at Teklanika West also produced a mid-Holocene date (Schweger 1985).

Faced with the issue that the Denali Complex had not been reliably dated, West compared the morphological similarities and differences between microblade tool kits of Denali Complex type sites to other microblade sites located outside of Central Alaska that had better chronological controls. West deduced that the stylistic elements of Denali Complex stone tool kits are more similar to known upper Paleolithic sites of East Asia such as at Lake Baikal in the Yenisei River Basin (Rainey 1939, 1940), and the Ushki Site (Dikov and Clark 1965) on the Kamchatka Peninsula, than to known Holocene era microblade sites within Alaska such as the Anangula Core and Blade Site (Laughlin and Marsh 1954) the Denbigh Flint Complex (Irving 1962), the Tuktuk Complex (Campbell 1961), and the Northwest Microblade Tradition (MacNeish 1964). His calculations concerning the age for a terminal Pleistocene age of the Denali Complex proved to be fairly correct with the discovery of several new Denali sites in the Nenana and Tanana valleys that generally date between 10,500-8,000 B.P. (Holmes 2011; Powers and Hoffecker 1989; West 1975, 1981).

The Chindadn component at Healy Lake was dated to 11,000 B.P., prior to all known Denali sites. The Chindadn Complex tool kit contained microblades and small bifacial convex based Chindadn projectile points not found within Denali Complex tool kits (Cook 1969; Dixon 1985; West 1967). In the first well-published cultural chronology of central Alaska, James Dixon classified all sites older than 11,000 B.P. as belonging to the Chindadn Complex, not the Denali Complex (Dixon 1985). Instead, Dixon referred to early Holocene microblade assemblages

found within the region as belonging to the American Paleoarctic Tradition (10,500-8,000 B.P.) which was followed by the Late Denali Complex (3,500-1,500 B.P.). The presence of a mid-Holocene horizon for the late Denali Complex (3,500-1,500 B.P.) is still being debated (Dixon 1985; Mobley 1996; Pearson and Powers 2001).

Until the discovery and excavations of the Dry Creek Site, wedge-shaped microblade cores and microblades had yet to be dated older than 10,000 B.P. With a radiocarbon estimate of 10,600 B.P., the Denali component at Dry Creek remains one of the oldest well-dated Denali Complex occupations within the Nenana and Tanana river valleys (Holmes 1974; Powers et al. 1983; West 1975, 1981).

The Denali Complex assemblage found at Dry Creek is one of the largest and most variable Denali assemblage known, containing a relatively high amount of projectile points and point fragments that are otherwise rare within Denali Complex tool kits (Powers and Hoffecker 1989; West 1981). In the C2 artifact clusters at Dry Creek, microblades were spatially segregated from projectile points and most bifacial knives (Hoffecker 1983; Powers and Hoffecker 1989). The segregation of technology may be indicative of various activities of a larger group of people, or represent a palimpsest of occupations of two or more smaller groups (Hoffecker 2011; Powers et al. 1983). During the 1980s, the only other Denali component in the Nenana region that could be dated was C2 at Panguingue Creek (8600-7000 B.P.), almost two thousand years younger than C2 at Dry Creek (Powers and Maxwell 1986; Thorson and Hamilton 1977).

Many of the Denali Complex type sites were re-excavated and new radio carbon dates and theories have been reported. In 1992, Ted Goebel and Nancy Bigelow excavated at Teklanika West, in part to date the Denali Complex occupation (Goebel 1992). The oldest component at Teklanika West was thought to date to the mid Holocene, approximately 7,000 B.P. In 2011, Coffman reported that the two oldest microblade components at Teklanika West are approximately 11,080-8,820 B.P. This was based on the analysis of bone collagen from bison remains found at the site. The dates suggest that microblades were used in the Nenana Valley almost 500 years earlier than previously reported, though the lack of diagnostic artifacts rules out placing the assemblage within any known archaeological complex (Coffman 2011).

Re-excavations of the Moose Creek Site revealed an additional Denali Complex component, the oldest of which dates to 10,500 B.P. (Pearson 1999), making it slightly younger than C2 at Dry Creek. The Denali assemblages at Dry Creek and Moose Creek are the oldest,

well-documented occurrences of the Denali Complex in the North Central Alaska Range. The oldest known Denali site may be the Little John Site (10,700 B.P.), which is located outside of the study area near the Canadian border (Easton et al. 2011).

Like the Denali Complex, the Dyuktai Tradition from northeast Asia utilized fairly similar microblade cores, microblades, burins, bifaces, and scrapers (Mochanov and Fedoseeva 1996). West (1996d) considers the Denali Complex to be a direct derivative of Dyuktai technologies. According to West the only major difference between Denali and Dyuktai tool kits is geography, with Denali found in central Alaska and Dyuktai occurring in northeast Siberia. Microblades and wedge shaped microblade cores are also associated with the American Paleoarctic Tradition (Anderson 1968, 1970a), as well as in the late Holocene, Northwest Coast Microblade Tradition of the Pacific Northwest (Clark 2001; Magne and Fredje 2007).

The Nenana Complex

Defining the Nenana Complex would not have been possible without the interdisciplinary efforts of the North Alaska Range Early Man Project (Hoffecker 1988). The results of the Dry Creek excavation inspired an expansion of this project, which led to the discovery of the Moose Creek Site and Walker Road (Hoffecker 1985; Powers and Hoffecker 1989). The lithic tool kits uncovered within the earliest components at Moose Creek and Walker Road resembled those found in C1 at Dry Creek. All three components contained a bifacial projectile point and end scraper lithic industry, missing were microblades, microblade cores, and related debris associated with the production and use of composite projectile points (Guthrie 1983). Radiocarbon dates estimated from charcoal taken from these three components indicated a human presence in the Nenana Valley between 11,800 to 11,000 B.P (Pearson 1999; Powers and Hoffecker 1989) much earlier than all of the known sites found within the Tanana River Valley.

Because of their combined age, the Nenana Complex type sites were hypothesized to represent the initial human occupation in the Nenana Valley around 12,000 B.P., well before microblades appeared in the region at 10,500 B.P. (Powers and Hoffecker 1989). This hypothesis was partly based on the observation that two Nenana components (Dry Creek C1 and Moose Creek C1) are stratigraphically situated beneath a microblade horizon. The Nenana Complex type sites predated all of the well-known microblade horizons in the Nenana Valley at Moose

Creek, Panguingue Creek, Little Panguingue Creek, Dry Creek (Pearson 1999; Powers et al. 1983; Powers and Hoffecker 1989, 1996), and Teklanika West (Goebel 1992; West 1965) in the Teklanika River Valley. With a possible early date of 11,800 B.P. from Walker Road, the Nenana Complex also predated all of the previously known microblade sites in the Tanana Valley (Cook 1969; Dixon 1985; West 1975, 1981).

At the time, the earliest known site in the Tanana Valley was the microblade occupation at Healy Lake (Cook 1969). The 11,090 B.P. occupations at Healy Lake are contemporaneous with the Nenana occupations at Dry Creek C1 and Moose Creek C1 (Cook 1969; Pearson 1999). Dixon (1985) classified all sites earlier than 11,000 B.P. as belonging to the Chindadn Complex and suggested that Dry Creek C1 was a non-microblade occupation of the Chindadn Complex. Cook (1969) described the Chindadn Complex as exhibiting cultural similarities to the Cordilleran Tradition (Butler 1961), and the Akmak level at Onion Portage (Anderson 1968, 1970b) in that there are bifacial projectile points in association with microblade cores, microblades, and burins.

When it came to classifying the earliest Nenana Valley archaeological sequence within a cultural historical construct, Powers and Hoffecker (1989) did consider whether the Nenana levels should be placed within the Chindadn Complex or if the Nenana components deserved their own separate classification. Powers and Hoffecker concluded that even though the addition of the Nenana Complex to the list of terminal Pleistocene era archaeological sites may look peculiar, it was warranted for two reasons. One was that the Nenana Complex might be significantly older than the Chindadn Complex (Powers and Hoffecker 1989). To arrive at this conclusion, Powers and Hoffecker referred to an unpublished list of 15 radiocarbon dates that indicated the early occupation at Healy Lake is actually 10,500-8,000 B.P., which is contemporaneous to the Denali Complex and the American Paleoarctic Tradition (Dixon 1985; West 1981) and earlier than all of the known Nenana Complex sites. The second was that microblades are also associated with the Chindadn Complex but not the Nenana Complex (Powers and Hoffecker 1989).

Additional resistance to accepting the 11,000 B.P. radiocarbon date of microblades at Healy Lake has come from claims that the Chindadn layer is cryoturbated which would have mixed the artifacts in the early horizon at Healy Lake (Erlandson et al. 1991) In 1996, John Cook published an expanded list of radiocarbon dates taken from charcoal samples from all of the

occupational horizons at Healy Lake. Cook reported that there are seven radiocarbon dates between 10,000-10,500 B.P., however two dates range from 11,100-11,410 B.P. Cook concludes that early period at Healy Lake dates between 11,400-8210 B.P. (Cook 1996).

After defining the Nenana Complex, Powers and Hoffeecker (1989) concluded that between 14,000-11,000 B.P., eastern Beringia was once occupied by two groups of people, one that utilized bifacial projectile technology and lacked microblades, and one who utilized microblade for side slotted composite projectile points versus bifacially worked lithic projectiles. Powers and Hoffeecker (1989) further deduced that the origin of this bifacial point technology was also established in Japan prior to the use of microblades (Aikens and Higuchi 1982; Ikawa-Smith 1978). Additionally, the late Pleistocene archaeological record of Siberia appeared to have been dominated by wedge-shaped microcore industries and the use of bifacial projectile points was rare (Powers 1973).

The Nenana Complex and Clovis Cultural Connections

The presence of bifacial point and blade technology and the absence of microblade technology within Nenana and Clovis tool kits have fostered a fair amount of formal comparison between the two industries in order to determine if they may, or may not be historically related (Buchanan and Collard 2008; Dixon 1993; Goebel 1989; Goebel et al. 1991; Hamilton and Goebel 1999; Powers et al. 1983; Powers and Hoffeecker 1989). In 1989, Ted Goebel pointed out that Clovis and Nenana Complex tool kits are both characterized by the presence of: (1) retouched blades, (2) end and side scrapers, and (3) bifaces and projectile points. A majority of Clovis assemblages do not exhibit blade-core technology, and the importance of blades to Clovis flint knappers has only been studied relatively recently (Collins 1999, 2004; Haynes 1982).

Goebel et al. (1991) compared Nenana complex and Denali Complex tool types sampled from Dry Creek C1 and C2, and Walker Road with the artifacts from two Clovis assemblages (Blackwater Draw and Murray Springs). Each artifact in the sample was examined for the presence of certain phenotypical attributes that were used to assign each sample into one of 15 artifact classes. Quantitative comparisons of the assemblages using cumulative percentage curves, and hierarchical cluster analysis to generate dendrograms suggested that Nenana complex tool types are more closely related to Clovis than the Denali

Complex of the American Paleoarctic Tradition. Goebel et al. (1991) argued that with the exception of projectile point forms, the Nenana Complex is virtually identical to Clovis industries in that neither Clovis nor Nenana technologies exhibit wedge-shaped cores, microblades, and burins. However, wedge shaped blade cores are found in Clovis tool kits (Goebel 1989). Goebel et al. (1991) concluded that Clovis and the Nenana Complex were the southern and northern remnants of the same migrational event.

In a cladistics study inspired by Goebel et al. 1991 work, Briggs Buchanan and Mark Collard (2008) hypothesized that the Denali Complex and Clovis are more closely related to each other than to the Nenana Complex. Using Goebel et al.'s (1991) dataset, Buchanan and Collard used a hierarchical clustering algorithm and distance measure to generate dendrograms that also suggested an ancestral relation between Clovis and Nenana as reported by Goebel et al. (1991). However, Buchanan and Collard used three different hierarchical clustering algorithms and 15 distance measures to produce dendrograms, which showed that the Denali Complex is more distant to Clovis. They also produced dendrograms showing the Nenana complex is more distant to Clovis than the Denali Complex. The multiple dendrograms were created using different combinations of clustering algorithms and distance measure employed and they suggested that Goebel et al.'s (1991) results lack reliability.

Buchanan and Collard also ran a separate cladistical analysis of Nenana, Denali, and Clovis tool types that indicated the Denali assemblage from C2 at Dry Creek is more closely related to the Clovis assemblages than to the Nenana sample. They went on to hypothesize that either Clovis is a descendent of the Denali Complex, or Clovis and Denali are descended from an unknown ancestral population (Buchanan and Collard 2008:1691).

When using cladistics analysis, the relations between the assemblages were not determined by the presence or absence of microblades. Buchanan and Collard (2008:1692) also point out that including microblades, which are unique to the Denali assemblage, are useless when trying to understand phylogenetic relationships between tool kits. They go on to argue that there has been too much focus on the presence or absence of microblade technology simply because Clovis tool assemblages lack microblades. What Clovis and the Denali Complex do have in common are elliptical bifaces, end scraper fragments, steeply keeled end scrapers, double-end scrapers, and wedges (Buchanan and Collard 2008).

Interestingly, both Goebel et al. (1991) and Buchanan and Collard (2008) have concluded that

the Denali and Nenana Complexes are more closely related to Clovis than either are to each other, yet both complexes have been found within relatively similar temporal and geographical distributions across the interior of Alaska within the Nenana and Tanana River valleys.

Even though there is a significant amount of archaeological variability within through the late Pleistocene and early Holocene transition, a definite Clovis precursor has yet to be identified in Alaska (Bever 2006). The oldest well-dated archaeological components in Alaska are found in the Tanana River and Nenana River Valleys. In this region, archaeological components dating to the late Pleistocene and early Holocene (12,000-10,000 B.P.) are all contemporaneous with, but do not predate the earliest known Clovis assemblages (Bever 2006).

In 2004, Bradley and Stanford hypothesized that Paleolithic Solutrean peoples may have colonized North America and are ancestrally related to Clovis. Bradley and Stanford based their analysis on the presence and absence of certain traits that are found in Clovis and Solutrean tool kits. Straus et al. (2005) argued that the similarities between Clovis and Solutrean tool kits were few, and is easily explained by adaptive technological parallelism versus historical connection. If parallelism can explain the similarities between Solutrean and Clovis tool kits, then it could also explain why similar tool types are found in Clovis, Nenana, and Denali assemblages as well.

It cannot be ruled out that the Nenana Complex is not related to Paleoindian population(s) whom inhabited Alaska interior at the end of the last Ice Age (Hoffecker 2005, 2011). Northern Paleoindians sites with fluted points also lack microblade technology and have been found outside the study area in the Northern Brooks Range, the Seward Peninsula, and along the Kuskokwim River between 11,660-9,730 B.P., which overlaps with Nenana Complex occupations (Ackerman 1996; Alexander 1987; Hoffecker 2011; Kunz and Reanier 1994, 1995; Powers and Hoffecker 1989). Today, Nenana Complex assemblages still lack microblades, wedge shaped microblade cores, or burins (Easton 2007), though a possible microblade-core-tablet has been identified in C1 at Dry Creek (Odess and Shirar 2007).

Early Microblades in the Tanana River Valley

As previously mentioned, during the early 1990s, the earliest appearance of

microblades in Central Alaska was dated to the early Holocene 10,500 and 10,700 B.P. (Powers and Hoffecker 1989). However, the presence of microblades in cultural zone 1 (CZ1) at Swan Point in the Tanana Valley dated over a thousand years prior to the Nenana Complex, changed this understanding (Holmes 2011; Holmes et al. 1996).

Archaeological excavations at Swan Point have uncovered microblades, and microblade cores that date to the late Pleistocene period. The Swan Point Site is located just upstream from the Broken Mammoth Site. The lowest level at Swan Point (CZ1) contains an early Dyuktai microblade horizon that predates all known non-microblade or Nenana components. At Swan Point, microblades have consistently dated between 12,360-11,660 B.P. (Bever 2006; Holmes 2011; Holmes et al. 1996). Cultural Zone 1 at Swan Point is also the oldest microblade assemblage in North America (Magne and Fredje 2007). It is also the only well-published site in Alaska with a microblade component below a possible Nenana component.

The Nenana occupation at Swan Point (CZ3) is dated between 10,270 B.P. and 10,790 B.P. (Ackerman 2007). Hoffecker (2001) and Holmes (2011) suggested that CZ1 at Swan Point belongs to the Dyuktai Complex, not to the Denali Complex. The Denali Complex is generally agreed upon to derive itself from Dyuktai industries (e.g. Mochanov and Fedoseeva 1996; West 1996a). Yesner (2001) suggested that an eastern Siberian Dyuktai population might have been pulled into the interior of Alaska by the flooding of the land bridge 12,000-11,500 B.P.

One of the oldest possible Nenana, or non microblade, components known today was uncovered at the Broken Mammoth Site, also located within the Tanana River Valley. The lowest level at Broken Mammoth (CZ4) dates between 11,800-11,200 B.P. (Holmes et al. 1996). Cultural material from this level is described as non-microblade, exhibiting evidence of bifacial flaking technology though lacking triangular points (Holmes et al. 1996). Cultural Zone 3 (CZ3) at Broken Mammoth is also a non-microblade horizon containing Chindadn points. This component was dated to 10,300 B.P. (Holmes et al. 1996).

In the Tanana Basin, with the exception of the unconfirmed status of CZ1 at Broken Mammoth, the Nenana/Chindadn Complex is clearly present at sites in the Tanana Valley, which are typically younger than the known Nenana sites within the Nenana River watershed. These people may have been pushed down from high alpine regions into the Tanana Valley

with the onset of the Younger Dryas (Bever 2006). Given the updated chronological history of the Tanana Valley, John Hoffecker (2001) redefined the pre-microblade hypothesis for the arrival of the Nenana Complex and now suggests that the complex dates to a microblade gap that occurred in the archaeological record between 11,500 and 10,800 B.P.

Alternate Views of the Nenana Complex

An alternative hypothesis is the Nenana Complex may be a non-microblade sub-component of the Denali Complex and that both complexes are part of a single widespread Beringian Tradition (Holmes 2001, 2011). Other models interpret the Nenana and Denali complexes as part of the same tool kit and interpret intra-assemblage variability in functional terms by focusing on site structure, subsistence, the past environment, and habitat use in relation to technological variability (Potter 2008a, 2011).

Denali Complex sites are found more frequently across the landscape than the Nenana Complex. Multiple Denali Complex components have been discovered throughout Central Alaska (Nelson 1935, 1937; Pearson 1999; Pearson and Powers 2001; Powers and Hoffecker 1989; West 1967, 1975, 1981). Late Pleistocene and early Holocene microblade horizons were uncovered at numerous localities including: Dry Creek (Hoffecker et al. 1996), Panguingue Creek (Goebel and Bigelow 1996), Teklanika West (West 1996b), Broken Mammoth (Holmes et al. 1996) and Swan Point (Holmes et al. 1996). The Tangle Lakes region of the south central Alaska Range is home to many late and middle Holocene components assigned to the Denali Complex, not the Nenana Complex (West 1996c).

An alternate hypothesis is that climate oscillations had an effect on human populations by changing the faunal and floral landscapes, thus altering subsistence patterns and tool kit design. The transition from the Pleistocene to the early Holocene had a profound effect on local climate and vegetation. The termination of the last Ice Age brought increased warming and moisture in central Alaska at approximately 12,000 B.P. between 11,000-10,000 B.P came the Younger Dryas (YD) cooling period, followed by the Holocene Thermal Maximum (HTM) warming period 10,000-9,000 B.P. (Ager 1975; Bigelow and Edwards 2001; Mangerud et al. 1974). Complicating the issue is that correlating multiple archaeological occupations with small-scale climatic shifts such as the Younger Dryas can be difficult. This is because when AMS dates sampled from lake cores are compared with standard radiocarbon dates reported

from many archaeological sites, the two data sets can be off from each other by a few hundred years (Bigelow and Powers 2001). This is relevant to research concerning human populations living during the YD, which may have lasted approximately 300 years in the Nenana River Valley versus the 1,000 year period in the North Atlantic regions (Bigelow and Edwards 2001).

Given the fact that the YD may have had a negligible effect on vegetation and climate in the Nenana River Valley, Bever (2006) hypothesized that the YD correlates with the disappearance of northern Paleoindians (including the Nenana Complex) from the archaeological record between 11,000-10,000 B.P. Potter (2008b) analyzed radiocarbon data, technological attributes, and subsistence and settlement patterns of known early Holocene sites. Potter suggested that though a depopulating event may have occurred during the YD, technological patterns and the subsistence economy were stable. Kelly Graf and Nancy Bigelow (2011) compared faunal and technological assemblages from interior Alaska before, during, and after the YD to see if it had an effect on technology and human subsistence patterns. Just prior to the end of the last glacial maximum < 12,000 B.P., the lower microblade horizon at Swan Point was the only known site that was occupied in the region (Graf and Bigelow 2011). With onset of the Younger Dryas (11,000 B.P) there was an abandonment of microblade technology, as known YD assemblages are represented by the Nenana Complex at Owl Ridge, Walker Road, Moose Creek, Dry Creek, and possibly Erodaway (Graf and Bigelow 2011). By 10,600 B.P., Tanana and Nenana foragers reincorporated microblades back into their tool kits, and bifacial technologies associated with the Nenana Complex continued in the Tanana Valley with the addition new concave base projectile points (Graf and Bigelow 2011). Graf and Bigelow concluded that between 14,000-10,000 cal. B.P., human occupations were continuous throughout the YD, though technological, subsistence, and land use strategies were altered (Graf and Bigelow 2011). Even though microblades were clearly selected for use by the end of the YD in Alaska, Graf and Bigelow do not provide an explanation how and why this may have occurred.

The Younger Dryas terminated with the onset of the HTM at around 10,000 B.P. During this period, human occupation in the uplands of the Tanana River Valley may have ceased, while human settlements continued in the lowlands as indicated by Denali Complex tool kits at Carlo Creek (Bowers 1980), the Phipps Site (West 1996a), and Whitmore Ridge

(Graf and Bigelow 2011; Mason et al. 2001; West 1996b).

In a desire to move away from cultural centric historical sequences, Holmes (2001, 2011) proposed a chronology that collapses the Denali and Nenana Complexes into a single wide spread *Beringian Tradition*. According to Holmes, the Beringian period represented the initial human occupation of central Alaska during a time when Siberia and Alaska were connected by the sub continental land mass known as the Bering Land Bridge (Hopkins 1967). Holmes's Beringian period is subdivided into two intervals; the first is pre-11,500 B.P., which only includes the Dyuktai Complex at Swan Point (Holmes 2011). The second Beringian period (11,500 and 11,000 B.P.) is characterized by the Chindadn Complex and the Nenana Complex in the archaeological record. The transitional period (11,000-8,500 B.P.) includes a continuation of the Nenana and the Denali Complex along with the American Paleoarctic Tradition (Holmes 2001, 2011). Potter (2011) also suggested the Nenana and Denali Complexes should be combined into one tradition. This is because several factors beyond normative templates (site sample bias, site location, human activities, and site function) can affect assemblage variability.

If the Denali Complex and the Nenana Complex are part of a single lithic tradition, and inter-assemblage variability is a function of differing site activities, then stylistic descriptions of particular points, bifaces, knives, and scrapers would still aid in the analysis of what activities may have required particular sets of stone tool kits. Collapsing two variables into one simplifies the problem. There is a real difference in how each complex is defined, and the use of archaeological complex descriptions still are useful in order to track the activities associated with stone tool variability. Cultural constructs cannot be ruled out entirely, and these questions are hard to answer from the remains of stone tools.

Currently, more is known about subsistence patterns during the Late Pleistocene and the Early Holocene period than was known 20 years ago. During the 1980s to early 1990s, the only well preserved faunal assemblages uncovered in terminal Pleistocene deposits came from C1 and C2 at Dry Creek, the Healy Lake Site, and Carlo Creek (Bowers 1980; Cook 1969, 1996; Powers et al. 1983). At Dry Creek, most of the identifiable faunal remains from C1 are tooth fragments of sheep and wapiti, while only bison and sheep remains could be identified in C2 (Guthrie 1983). The presence of bifacial projectile points and bison and wapiti remains indicated that early humans that inhabited Alaska were big game specialists.

Today, more is known about the diversity of food resources that were exploited by hunter-gatherers in central Alaska around the late Pleistocene period (Potter 2008a; Yesner 2001). In the first direct comparison of 24 early Holocene sites in central Alaska with identifiable faunal remains, Potter (2008a:101) demonstrated that early humans living in the region depended on a variety of large and small fauna, including: bison, wapiti, caribou, sheep, and birds, which are reported in most abundance, followed by moose, hare, fish, canid, bear, beaver and mammoth.

In the Tanana River Valley, the excellent preservation of remains at the Broken Mammoth and Swan Point sites demonstrates that early humans seasonally exploited a variety of large and small game, and aquatic resources (Holmes et al. 1996; Yesner 2001, Yesner et al. 2011). At Broken Mammoth, 90% of the fauna were located within the lower two components. The remains of bison, elk, bear, wolf, arctic fox, arctic ground squirrel, hare, river otter, marmot, pika, swans, Canadian geese, snow geese, white fronted geese, mallard ducks, pintails, gadwalls, and ptarmigan, along with grayling and possible salmon have been reported (Yesner 2001). In CZ4 at Swan Point, the remains of grouse, ptarmigan, ducks, geese, possible horse, caribou, elk or moose have also been identified. Mammoth bones and tusk were also recovered though it is not clear if mammoths were hunted, or their remains scavenged (Yesner 2001). Scavenged bones may have been burned and used as a heat source, while mammoth tusk may have been used to fashion composite projectiles (Holmes 2011; Yesner 2001). Given the diverse array of resources that early humans have harvested, it would be likely that designing a highly adaptive subsistence tool kit, capable of harvesting a diverse amount of food resources on a seasonal basis would be fundamental to human survival, especially in subarctic regions.

For the first time, Nenana Complex organic tools were discovered in CZ 4 of the Broken Mammoth Site (Holmes 1996; Yesner et al. 2011). CZ4 revealed an eyed needle along with mammoth and ivory implements (Yesner 2001). A bone toggle and a possible atlatl handle, and ivory rods were also unearthed, illustrating the likelihood that miniature Chindadn/Nenana projectile points were manufactured as dart tips for composite atlatl technology (Yesner 2001).

The length of time a site was occupied may also factor into the technological variability seen in early Holocene archaeological assemblages of central Alaska. The Broken Mammoth

and Swan Point sites, which contain a high amount of faunal remains, artifacts, and features, were likely longer term seasonal camps (Yesner 2001). The general absence of hearth features in C1, and C2 at Dry Creek may indicate a shorter term camp for a mobile group of foragers or collectors. The position of Dry Creek on a river terrace may have provided a source of water and a chance for its occupants to view game while conducting other site activities.

John Cook (1969) suggested that the Healy Lake Village Site was a continually occupied settlement, with microblades occurring throughout the stratigraphic sequence. A possible tent ring has been reported at Walker Road that may indicate a relatively short term base camp for the Nenana occupation there as well (Goebel 2011; Goebel et al. 1996; Powers et al. 1990). A longer term occupation may also explain why the Walker Road Site revealed the largest and most diverse Nenana Complex set of artifacts known to date. The Upward Sun River Mouth Site (Potter et al. 2011) revealed a semi subterranean house feature dated to approximately 10,000 B.P. in the Tanana River Valley. The presence of a relatively permanent dwelling stands in contrast to the logistically oriented overnight spike camps believed to be associated with C1 and C2 at Dry Creek (Powers et al. 1983).

The availability of raw materials may have also had an effect on the make-up of Nenana and Denali tool kits. Goebel (2011) suggests that the Nenana and Denali Complexes tool kits differ in their use of local (Nenana) versus non-local (Denali) raw materials to construct their tool kits. The analysis of debitage suggests an emphasis toward primary and secondary reduction of local tool stone for the Nenana Complex at the Walker Road Site, while obsidian microblades are associated with C2 at Dry Creek. Goebel (2011) also stated that the relationship between the Nenana Complex and the Denali Complex may be too complicated to unravel, and that future research should focus on behavioral questions addressing the similarities and differences between Nenana and Denali raw material procurement, tool production, tool function, and site activities.

Conclusions

Given Thorson's (2006) hypothesis that a majority of the Nenana assemblage at Dry Creek may be a part of the Denali component (C2), the possible occurrence of most of the C1 and C2 tool kits appearing at once in a single assemblage is intriguing, since it would more than double the size of the Nenana assemblage at Dry Creek. However one must show that at

least some, if not all, of the corresponding clusters in C1 and C2 were related. This could be done through alternative research methods such as refit analysis, which is outside the scope of this study.

Given that the Swan Point Site in the Tanana Valley has microblades that predate the Nenana Complex, and that Nenana-like triangular bifaces have been found with and without microblades in the Nenana and Tanana River valleys, it is possible to consider whether these assemblages are the remnants of particular site activities of a single population inhabiting central Alaska, rather than two different cultural groups as proposed by Goebel et al. (1991). If the known lithic technological variability of central Alaska is compared to the Northern Brooks Range region (12,000 and 10,000 B.P.) we find that the Mesa Complex, with diagnostic fluted bifacial points in their tool kits, may indicate an influx of Paleoindian bison hunters from the plains regions of the continental U.S. (Hoffecker 2005, 2008). Given that Paleoindian groups were likely present within the region, the classification of the Nenana Complex within the Northern Paleoindian tradition may have merit (Bever 2001; Hoffecker 2011; Kunz and Reanier 1995).

In the ongoing discussion of lithic technological variability, no single study will completely unravel the complexities of artifact function and style in relation to prehistoric human migration patterns. The author hopes to show that with relatively inexpensive techniques we might be able to compare the range of activities associated with certain tool sets by hypothesizing upon functional similarities and differences between Nenana Complex and Denali Complex tool kits.

CHAPTER IV: RESULTS

Formal Tool Results

In order to gauge the activities associated with formal and informal tool sets, the results presented in this chapter will focus on answering the following questions: (1) What activities were each sample of tools last used for? (2) What materials was each sample of tools last used upon? (3) Were any tools hafted? (4) What tools, if any, were multifunctional?

A total of 173 bifacial, unifacial, blade, flakes, and burins were selected from the Nenana and Denali tool assemblages of the Dry Creek Site. The Denali sample (n=144) is significantly larger than the Nenana sample (n=29). The difference in sample size is approximately equal to the difference in component size, given that the Denali lithic assemblage is roughly 12 times larger than the Nenana assemblage.

The sample of tools is composed of 10 general lithic material types, ninety-nine percent of which are locally available. The types of toolstone within the sample includes: chert, rhyolite, basalt, quartzite, chalcedony, argillite, obsidian, jasper, pumice, and undetermined (Figure 2). The C1 sample is composed of five different material types, while the C2 sample includes nine different material types. Chert is the most common material type sampled from each component, approximating 44% of the total sample.

In C1, 22 artifacts (75.8% of the sample) are made of chert, followed by chalcedony (n=3 [10.3%]), rhyolite (n=2 [6.9%]), basalt (n=1 [3.5%]), and undetermined (n=1 [3.5%]). In the C2 sample, 54 artifacts are made of chert (37.5% of the sample), followed by rhyolite (n=32 [22.2%]), basalt (n=31 [21.5%]), and quartzite (n=16 [11.1%]). Less common materials are: chalcedony (n=4), argillite (n=3), obsidian (n=1), jasper (n=1), pumice (n=1), and undetermined (n=1), which comprise 7.7% of the sample of tools from C2.

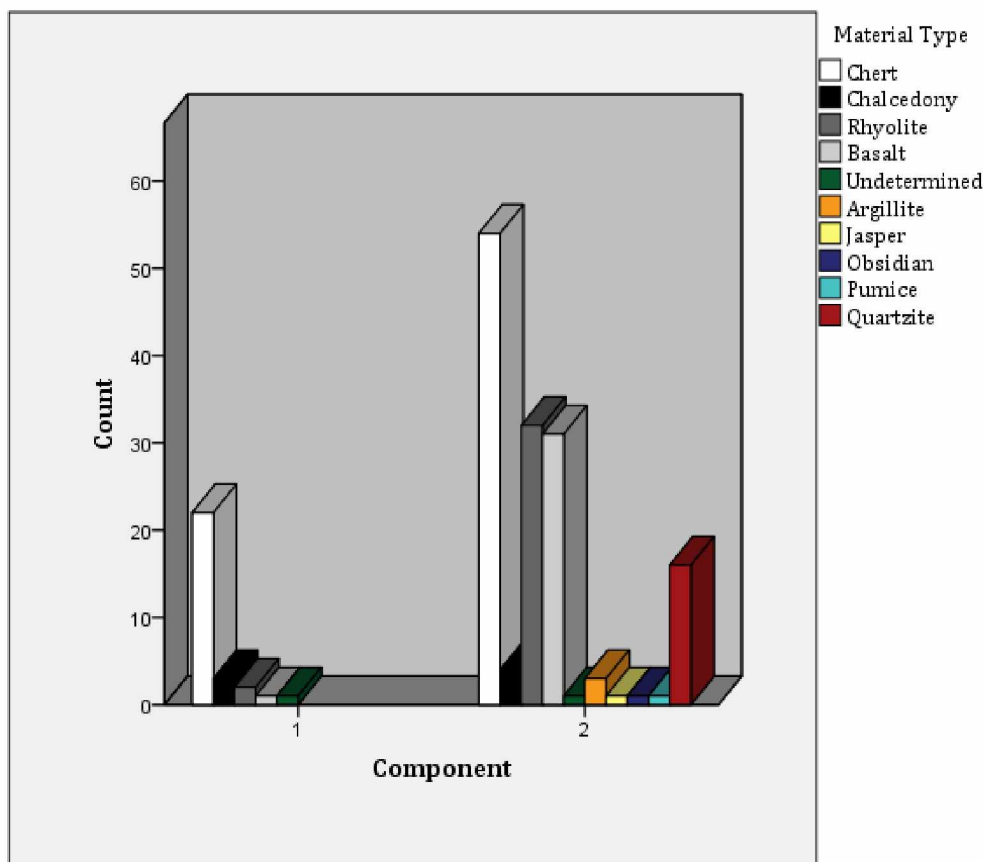


Figure 2 Sample of C1 and C2 lithic raw material types.

Utilized Tools

The frequency of utilization is the percentage of tools within each sample that were utilized. Approximately 86% of the C1 tool sample were utilized, while roughly 59% of the tools from C2 exhibited signs of utilization. The formation of identifiable microwear patterns on utilized elements of a tool is generally dependent on the type of activity associated with each tool, how long each tool was used for, and the type of material that was worked. Highly curated tools may also exhibit better developed wear patterns than non-curated tools, since they are used until their uselife has been expended.

Fisher's exact test is a statistical significance test used to evaluate whether two variables are independent. This test is preferable over Pearson chi-square analysis for any 2 x 2 data contingency table that has a cell with a value less than 10. Like the Pearson chi-square test of independence, a p-value lower than .05 indicates that there is less than a 5% chance that two variables are related. A significance level less than .05 doesn't confirm that two variables are

actually independent, one can only conclude there is not enough evidence to confirm they are not independent. A downside to Fisher's test is that it is less likely to find true differences between samples than Pearson chi-square analysis, but it is more accurate for smaller sample sizes like the Nenana tool set. The p-value for the number of utilized tools in each sample is .006, which suggests that the difference in the number of utilized tools within each sample is significant.

Utilized Formal Tools

There are 101 bifacially worked and unifacially worked flakes, blades, and fragments within the formal tool sample. The C1 sample includes 15 tools and tool fragments, while the C2 sample includes 86 tools and fragments. Because the sample sizes may be biased towards C2, the results presented here, and in the following sections, are preliminary. Approximately 86.7% of the formal artifacts from C1 were utilized, while 58.1% of the C2 sample exhibited signs of use, a difference of approximately 29%. The Fisher's significance level for the number of utilized formal tools in each sample is .044.

There is a fair amount of morphological variability between bifacial tools and scrapers from each sample. The C2 bifacial tool assemblage contains a greater number, and wider variety, of bifacial knives and projectiles than C1. In contrast, the C1 assemblage has a higher ratio of unifacially worked scrapers over bifacial tools than C2 (Powers et al. 1983). Approximately 55% of the formal tools sampled from C1 are unifacially worked scrapers (primarily end scrapers), while 70% of the formal tools within the C2 sample are either a biface, or a biface fragment.

Utilized Bifacial Tools

The bifacial tool sample includes complete and refit formally shaped bifaces. Biface fragments are reported later in this section. The combined C1 and C2 bifacial tool sample consists of 29 artifacts. There were three complete bifacial tools sampled from C1 and twenty six bifaces sampled from C2. Only one of the C1 bifaces from C1 was utilized, (33.3% of the sample), while 12 (46.1 %) of the bifacial tools from C2 were utilized (Table 3 and Table 4). There is only one finished bifacial knife in the C1 assemblage, which is included in the sample. The other two bifacial knives recovered from C1 (one of which was sampled) are bifacially thinned and shaped preforms that broke during manufacture (Powers et al. 1983). The single

utilize bifacial knife in the C1 sample was originally reported as a bifacial base and a point tip and were fit back together after the 1983 report was released. Given the unequal proportions between the C1 and C2 samples of bifacial tools; there does appear to be a relatively low number of utilized bifacial tools from each component. The Fisher's exact test p-value is 1.0, which further indicates that the percentages of utilized bifaces from each component are similar to one another.

The C1 bifacial tool sample consists of two bifacial knives and one triangular shaped Chindadn point. As previously mentioned, only one biface appears to have been utilized. The form of the utilized biface appears unfinished and looks similar to a later stage biface than a finished biface. There is a light amount of bidirectional cutting, or, possibly sawing wear on one margin of the blade. The utilized edge is slightly rounded, roughened, and exhibits alternating to uneven distributions of snap, and eroded feather fractures. The appearance of a roughened tool edge and random distribution of snap fractures are indicative of cutting through tendons and meat during butchering activities (Flannigan 2002; Odell 1980; Tringham et al. 1974).

The utilized bifacial knife from C1 also exhibits possible hafting wear along the proximal right and left lateral margins of the knife. The wear appears as edge damage consisting of slightly ground and rounded overlapping hinge and step fractures (Figure 3). There is a bright reflective polish within the hafted area of the knife. The polish is very reflective though it may be an artificial sheen that formed on the tool after it was discarded. The usewear pattern on the blade of the knife appears to have been secondarily modified by both taphonomic and cultural processes as well. The ridges of the microwear scars on the utilized element of the blade are rounded, making flake scar terminations harder to interpret. The same attritional process that created the surface sheen visible on the rest of the artifact likely rounded the flake scar ridges on the tool as well. Additionally, a portion of the microwear on the ventral edge of the blade was intentionally removed by retouch, which effectively erased some of the microwear off the blade.



Figure 3. Small rounded snap fractures on the utilized element of a refit chert knife from C1 (20x).



Figure 4. Rounded edge exhibiting overlapping fractures in the hafted area of a refit chert knife from C1 (8x).

Table 3. Bifacial tools sampled from C1.

<i>Morphology</i>	<i>Raw Material</i>	<i>Utilized</i>	<i>Multifunctional</i>	<i>Activity</i>	<i>Hafted</i>	<i>Material Worked</i>
refit bifacial knife	chert	yes	unknown	cut	yes	soft, soft hard
triangular projectile point	chert	unknown	unknown	n/a	yes	n/a
refit bifacial knife	chert	unknown	unknown	n/a	unknown	n/a

There are 26 bifaces within the C2 tool sample. C2 bifacial tools were previously subdivided into ten formal types (Powers et al. 1983) (Figure 5). As previously mentioned, approximately 44% of the bifacial tools sampled from C2 exhibit identifiable signs of use. A majority of the bifaces that were not utilized are miscellaneous bifaces. The miscellaneous bifaces are typically unfinished tools that may have functioned as cores, or were simply abandoned during manufacture (Andrefsky 2005; Powers et al. 1983).

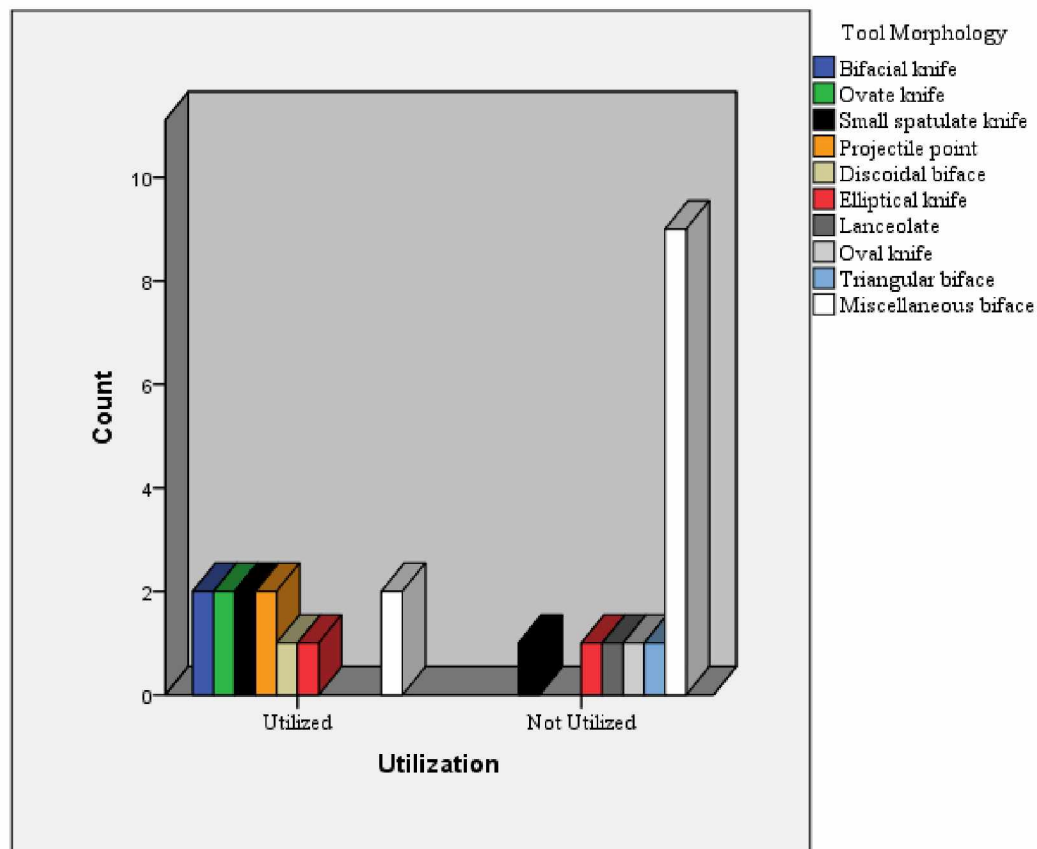


Figure 5. C2 Biface morphology and utilization.

Materials Worked

The variable of material worked is divided into two broad categories of resistance: soft to soft-hard, and medium-hard to hard. These categories are broad enough to hypothesize on the general range of materials a particular item may have been used for, based on its resistance towards the softer, to increasingly solid end of the spectrum. Even though it may not be possible to hypothesize on the specific material that each utilized edge was used on, it is possible to explore whether certain tools were handled more conservatively than others were.

Approximately 58.3% of all utilized bifaces from C2 were used for activities involving relatively harder materials such as fresh bone, wood, or antler. Correspondingly, 41.7% of the utilized bifaces were used against more yielding materials such as meat, hide, tendon, skin, or vegetal tissue. The ratio between utilized bifaces and relative material worked may suggest that there was a slight bias to use bifacial tools (e.g., projectile points, knives, and a single scraper) on

materials that are harder; however, approximately 71.4% of the utilized bifacial knives were used to work softer materials.

Hafted Bifacial Tools

Of the 12 bifaces from C2 that were utilized, 7 may have also been hafted. Of the hafted bifaces, 71.4% (n=5) were used on softer materials. Two of the hafted bifaces are projectile points that exhibit impact damage, or fractured, from hitting a medium-hard to hard material such as bone of an intended target. If the projectile points were to be removed from the sample, the frequency of use of formal hafted bifacial knives on softer materials rises to 100%. This may further indicate a conservative use of hafted bifacial knives for lighter tasks involving softer materials that create less damage to the tool.

Activities

The utilized bifaces from C2, conducted a variety of tasks involving softer and harder materials. Approximately 60% of the C2 utilized bifaces were knives used for unidirectional “cutting” and/or bidirectional “sawing” activities. Bifacial knives may have also been used for expedient scraping tasks involving soft to soft-hard materials. This type of wear may be the result of shaving meat from hide and/or bone. One small bifacial projectile point exhibits a crushed tip with multiple overlapping hinge fractures (Figure 6). Experimental studies have shown that this type of damage can form on the tips of projectiles after impacting hard bone, or even stone (Odell and Cowan 1986; Shea 1988, 2008).



Figure 6. Crushed tip of a bifacial projectile point from C2 (20x).

At least two bifaces (an ovate knife and a small spatulate knife) may have been used for expedient scraping and/or hide shaving activities. The discoidal biface appears to primarily have functioned as a scraper. The unifacial edge damage on the discoidal biface suggests scraping harder materials, such as bone or antler, while the more isolated microwear patterns on the ovate and small spatulate knives suggests scraping-shaving softer materials and occasional contact with bone or antler. This type of microwear pattern may be associated with butchering activities involving cutting and shaving meat off of bone. The ovate knife also has a hinge fracture at the tip that may be the result of contacting bone or joints after stabbing into an object, possibly while butchering a larger animal.



Figure 7. Continuous, overlapping unifacial hinge fractures on the discoidal bifacial scraper from C2 (10x).

Most of these bifaces may have been used as knives to cut and pierce into soft and/or denser materials such as thick muscle tissue, tendons, and ligaments. Butchering activities may have snapped the tips off at least one bifacial knife. Hunting and field butchering activities likely resulted in a high number of broken bifacial tools that would have had to be replaced prior to completion of the task. Utilized bifacial knives and projectiles often broke within their haft, further indicating strenuous activities that frequently resulted in tool failure.

Identifying the activities of knives, and other tools, used to work softer materials (meat, tendon, fresh hide, skins, soft vegetal materials etc.) was limited by the general absence of clear use polishes and striations on virtually all of the formal and informal tools in the sample. The presence of abrasional wear patterns such as polishes, rounded edges, and striations also contribute to the identification of utilized tools, tool motion, and the material worked (Bamforth 1990; Keeley 1980; Keeley and Newcomer 1977; Moss 1983; Rots et al. 2011; Vaughan 1985). The presence of abrasional patterns on a tool edge would indicate a utilized element even when there is no edge damage, which may have resulted in a higher number of identifiable utilized tools in both samples. Most of the formal and informal tools sampled from the Dry Creek C1 and C2 assemblages have a clear, often macroscopically visible, secondary sheen along the edge margins and flake ridges of the artifact. All secondary polishes observed on the tool sample used for this study are referred to as a surface sheen, or sheen.

The process that developed the sheen may have erased abrasive usewear signatures such as use polish, edge rounding, and weakly developed striations. Miscellaneous sheens develop on lithic tools from a variety of processes. Cleaning artifacts under water with a toothbrush can create a sheen on the surface of a tool. It is best to clean lithic artifacts with a sterile nylon brush on a dry surface in order to preserve abrasional polishes that may exist on utilized tools (Levi Sala 1986). The secondary polish may also be a soil sheen that often forms on lithic tools as they move through wet abrasive sediments containing sand (Burroni et al. 2002; Levi Sala 1986; Moss 1983). The sheen could also be a wind gloss from blowing silt if the artifacts were left on the surface long enough. Stapert (1976) suggested that rounding of ridges and edges on lithic tools was due to having been in wet soils for an extended period of time. Rottländer (1975) suggested that the formation of gloss on flints occurs in acidic environments, such as peat layers. The process that developed the sheen also eroded large and small flake scar terminations by smoothing flake ridges, making identification of lighter, isolated microwear patterns more difficult. Because of the particular high frequency of tools that have a sheen, it is likely that small abrasive utilization signatures such as such as striations and polishes were erased from utilized edges by post depositional processes relating to site formation and the natural environment.

Table 4. Utilized bifacial tools sampled from C2.

<i>Morphology</i>	<i>Material Type</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Range of Materials Worked</i>	<i>Hafted</i>	<i>Multifunctional</i>
miscellaneous biface	chert	2	cut	medium-hard, hard	unknown	unknown
small spatulate knife	rhyolite	1	cut	soft, soft-hard	yes	unknown
ovate knife	basalt	1-2	cut	medium-hard, hard	possible	yes
bifacial knife	rhyolite	1	cut	soft, soft-hard	yes	unknown
elliptical knife	rhyolite	1	cut	soft, soft-hard	yes	unknown
bifacial knife	chert	2	saw	medium-hard, hard	yes	unknown
miscellaneous biface	quartzite	2	saw	medium-hard, hard	unknown	unknown
projectile point	chert	1	impact	medium-hard, hard	yes	unknown
projectile point tip and base	rhyolite	1	impact	medium-hard, hard	possible	unknown
small spatulate knife	chert	1	scrape-shave	soft, soft-hard	yes	unknown
ovate knife	chert	1	scrape-shave	soft, soft-hard	unknown	unknown
discoidal biface	chert	1	scrape	medium-hard, hard	unknown	unknown

Biface Fragments

Biface fragments were analyzed in order to assess if they were utilized prior to breaking. Additionally, the analysis of the bifacial tool fragments may also highlight whether certain implements were recycled for additional tasks prior to being discarded. This is done in order to get a sense of how bifacial tools may have been handled throughout their use-lives between both components.

There are three biface fragments in the C1 sample: one distal biface fragment, and two projectile point bases (Table 5). There is an isolated area of unifacial edge damage on a proximal biface fragment. This utilized area consists of both hinge and snap terminated microfractures that

are visible within retouch flake scars along the edge. Microwear flake scar orientations are both perpendicular and oblique to the edge, which is indicative of unidirectional shaving, or scraping motions, of a more resistant material (Flannigan 2002; Odell 1980; Tringham et al. 1974). Additionally, a combination of unidirectional scraping and cutting activities might develop a similar wear pattern, if the same element was used for both activities.

The two projectile point bases in Table 5 are hypothesized to have been utilized based on the conclusion that the point tip broke away from the base at the location of hafting. This is indicated by the presence of a large hinge fracture visible at the break location. Experimental studies have shown that hinge fractures and/or step fractures often form at the tip and base of hafted projectiles after one or more impacts into bone (e.g., Odell and Cowan 1986; Rots and Plisson 2014). In addition, both of the point bases broke apart at approximately 5 mm from the proximal margin of the tool. The break location of the point bases corresponds to the complete triangular point, which exhibits a 5 mm ground area (on the left and right corners of the base of the tool) where it was also hafted.

Another projectile point base exhibits spontaneous retouch on a small isolated area within the hinge fracture where the blade snapped from its base (Figure 8). Spontaneous retouch occasionally occurs on the distal edges of flakes once they are struck from their objective core with a hammer (Newcomer 1976). Spontaneous retouch can occur when the distal end of the flake makes contact and pivots away from the objective piece, at just the right angle for microflakes to detach. A similar situation may have occurred when the point impacted its target, causing the blade to pivot against the margin of the point base, in a unilinear direction, leaving an isolated area of edge damage at the break location that is similar to unifacial scraping wear. Chindadn points have been also hypothesized to be small knives (Dixon 1999). The presence of perpendicular spontaneous retouch would suggest that this tool was used as projectile point, versus a knife.



Figure 8. Spontaneous retouch exhibiting feather and hinge fractures at the break location of a triangular projectile point base from C1 (30x).

The fact that the point base fragments were recovered at the site may imply that foreshafts were valuable enough to be recovered and brought back to the campsite to be retooled. The thinness of the projectile points from C1 may be multifunctional. The triangular point and point fragments may have been designed to break upon impact. Once the point broke, it would imbed itself deeper into the target as a wounded animal flees, and also drop the foreshaft for easy retrieval.

Table 5. Biface fragments sampled from C1.

<i>Morphology</i>	<i>Material Type</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Material Worked</i>	<i>Hafted</i>	<i>Multifunctional</i>
projectile point base	chert	yes	n/a	projectile	n/a	yes	unknown
projectile point base	chert	yes	n/a	projectile	n/a	yes	unknown
knife blade	chert	yes	1	cut	soft, soft-hard	unknown	unknown

There were 26 biface fragments sampled from C2 of Dry Creek. There are 15 distal biface fragments within this sample (Table 6). Approximately 47.6% of the distal biface

fragments sampled from C2 were utilized. This is approximately the same utilization rate of complete bifacial tools from C2 (42.3%).

Approximately, 57.1% of the distal biface fragments were once used as a knife. The remaining utilized fragments (42.9%) exhibits unifacial and perpendicular edge damage indicative of unidirectional shaving. At least two of the distal fragments were utilized to cut and scrape softer materials. One distal fragment was used to scrape both soft and hard materials. One utilized element exhibits a line of unifacial perpendicular feather fractures indicative of cutting softer materials. The feather fractures are followed by unifacial perpendicular hinge and step fractures indicative of use against harder material such as bone. A slight majority of the distal biface fragments (57.1%) exhibit edge damage consisting of rounded utilized elements with feather fractures that are indicative of cutting through softer material types. This is a little more than the majority of utilized complete bifaces from C2, 45.4% of which were also used on softer materials.

Table 6. Distal biface fragments sampled from C2.

<i>Morphology</i>	<i>Material Type</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Range of Materials Worked</i>	<i>Hafted</i>	<i>Multifunctional</i>
knife blade	argillite	yes	1	cut	soft, soft-hard	unknown	unknown
knife blade	basalt	yes	1	cut	soft, soft-hard	unknown	unknown
knife blade	chert	yes	2	cut	soft, soft-hard	unknown	unknown
knife blade	chert	yes	2	saw	medium-hard, hard	unknown	unknown
miscellaneous	chert	yes	2	scrape	medium-hard, hard	unknown	unknown
miscellaneous	chert	yes	1	scrape	soft, soft-hard	unknown	unknown
knife blade	quartzite	yes	1	scrape	soft, soft-hard	unknown	unknown
elliptical knife tip	basalt	unknown	n/a	n/a	n/a	unknown	unknown
distal biface fragment	basalt	unknown	n/a	n/a	n/a	unknown	unknown
distal biface fragment	basalt	unknown	n/a	n/a	n/a	unknown	unknown
distal biface fragment	chert	unknown	n/a	n/a	n/a	unknown	unknown
distal biface fragment	chert	unknown	n/a	n/a	n/a	unknown	unknown
distal biface fragment	quartzite	unknown	n/a	n/a	n/a	unknown	unknown
distal biface fragment	quartzite	unknown	n/a	n/a	n/a	unknown	unknown
distal biface fragment	quartzite	unknown	n/a	n/a	n/a	unknown	unknown

There are 11 proximal biface fragments within the C2 sample. The sample includes: five projectile point bases, three knife bases, and three miscellaneous biface bases (Table 7). The proximal knife fragments have been subdivided into one knife fragment and two small spatulate knife bases (Powers et al. 1983).

It would be easier to exclude proximal bifacial knife and projectile fragments in analysis. After all, it is expected that most (if not all) of any the original utilized edges would no longer be attached to the base of the tool. This would make differentiating between bifacial knives and projectile points difficult. Given this scenario, approximately 9.1% of the sample (one artifact) has edge damage that likely relates to use as a knife. The remaining sample, however, was unutilized in terms of retaining significant edge damage signatures, however hafting signatures could be identified.

Proximal Biface Fragments

Approximately 54.5% of the C2 proximal biface fragments may have been prehended in a haft. Hafting wear was inferred based on the occurrence of continual perpendicular step and hinge fractures along the basal portions, and at least one lateral margin of the artifact. Approximately 86% of the hafted bifaces also exhibit well-developed rounded edges within the hafted area, when compared to other regions of the tool. Approximately 29% of the hafted biface fragments also exhibit crushed edges, in combination with edge rounding and microfractures within the hafted area. The proximal biface fragments were previously categorized as knife or point bases. However, it is difficult to discern whether they were used as knives or projectiles without the entire blade. All of the knife and projectile point bases exhibit similar breaking patterns with both categories of tools breaking at a clean snap, or shallow hinge fracture. It is likely that most of the tools within this sample were utilized as either a knife or a projectile since both sets of activities could snap the blade off.

A majority of the proximal biface fragments within the C2 sample were not recycled for other purposes once they broke except for the possibility of an obsidian point base. The obsidian from the site may have been traded or directly procured (Reuther et al. 2011). The obsidian point base may have initially been used as a projectile point, which caused it to break at a well-defined hinge fracture at the distal end of the tool. The opposite end of the base (where it was originally hafted) is pointed, exhibiting a clean snap fracture just beneath the tip of the artifact. Given that

the margins along the proximal hinge fracture are ground more than the distal snap fracture, it is possible that after the point first broke it was flipped over, re-hafted, and used again-possibly as a knife. There is significant marginal edge damage along the right and left lateral margins leading to the snap fracture at the tip. This may be indicative of sawing a relatively hard material given that the lateral margins are also ground; and rounded. However there are frequent randomly oriented striations all over on the surface of the tool, which may indicate it was secured within a haft, which may have caused some edge damage as well. Yet the patterns of flake scarring are bi-lateral continuously overlapping hinge and snap fractures that are medium to very small in size, which are indicative of a well-used knife edge.

The right and left lateral margins at the proximal hinge fracture are heavily crushed and abraded, more so than on other areas of the tool which may also indicate hafting wear. There is a notch on the right lateral margin of the tool that also suggests where it was prehended. The same area on the opposite lateral margin is missing, having been sawed off for obsidian hydration analysis. This biface fragment is the only obsidian tool within the entire sample. Its glass-like texture appeared to preserve microwear patterns better than other material types in this study. For instance, striations are not visible on other tools, however, striations are covering the dorsal and ventral surfaces of the artifact. Aside from striations, obsidian artifacts may preserve edge damage from erosional processes better than the other material types as well, given that there is no clear sheen present on the surface of the tool.

Table 7. Proximal biface fragments sampled from C2.

<i>Morphology</i>	<i>Raw Material</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Range of Materials Worked</i>	<i>Hafted</i>	<i>Multifunction-al</i>
point base	obsidian	yes	2	projectile and saw	medium hard, hard	yes	possible
small spatulate knife base	rhyolite	unknown	n/a	unknown	unknown	yes	unknown
knife base	rhyolite	unknown	n/a	unknown	unknown	yes	unknown
small spatulate knife base	chert	unknown	n/a	unknown	unknown	yes	unknown
point base	basalt	unknown	n/a	unknown	unknown	yes	unknown
point base	basalt	unknown	n/a	unknown	unknown	yes	unknown
point base	quartzite	yes	unknown	unknown	unknown	unknown	unknown
biface base	rhyolite	unknown	n/a	unknown	unknown	unknown	unknown
biface base	basalt	unknown	n/a	unknown	unknown	unknown	unknown
point base	rhyolite	unknown	n/a	unknown	unknown	unknown	unknown
biface base	basalt	unknown	n/a	unknown	unknown	unknown	unknown

The results suggest that bifacial tools from both the Nenana and Denali components were used as knives and projectiles. Six utilized bifaces from C2 indicate use for limited scraping activities, whereas scraping wear was not observed on any of the bifacial tools from C1. There is a slight tendency to use bifacial tools to scrape relatively yielding materials versus harder materials. Of six bifacial tools and fragments that exhibit scraping wear from C2, approximately 67% (n=4) were used on generally softer materials. The discoidal bifacial scraper is the only complete biface in the sample that scraped a harder material type.

Given the limited number of bifaces that were sampled from C1, there is no indication that these tools were used for activities other than as a projectile, or a knife. However, there is no reason to assume that bifacial tools could have just as easily been used for scraping activities in the Nenana Complex as well. The bifacial scraper in C2 is unique, given that all of the scrapers in C1 are unifacially worked. A larger sample of Nenana Complex bifacial tools could provide a more in depth view of the range of activities that these tools may have been used for.

The C2 sample of bifacial tools and fragments suggests that bifacial tools as a whole were almost evenly divided between working either hard or soft material types. Approximately 41.6 % of the complete utilized bifaces (and 57.1% of utilized distal bifacial fragments) were used on generally softer (versus harder) materials. The type of material worked may vary around whether the biface was used as a knife (for cutting generally softer materials) or a projectile point (impacting generally harder, or more resistant materials). Roughly 71.4% of the C2 sample of utilized complete bifacial knives were used on softer materials. All of the utilized complete knives from C1 and C2 that exhibit hafting wear signatures were used on generally softer materials.

Scrapers

The utilization frequency of scrapers sampled from both components is approximately 87.5%, which is significantly higher than complete bifacial tools at approximately 43%. There are eight scrapers sampled from C1, and seven scrapers from C2. All of the C1 scrapers appear utilized, while five scrapers (71.4%) from C2 exhibit indications of use.

The scrapers that were sampled from C1 are classified as an end scraper, side scraper, or an end-side scraper (Table 8). Approximately 87.5% of the C1 sample of scrapers are end

scrapers, including the end-side scraper (Table 8). There is only one side scraper in the C1 sample. All of the scrapers selected from C1 have at least one utilized element that indicates their use as scraping tools. Approximately 33% of the scrapers exhibit evidence of more than one activity and were used as both a scraper and a knife. Five of the six endscrapers exhibit hafting wear. Hafting on endscrapers is indicated by the presence of crushed flake scars concentrated in one area on both the distal right and left lateral edges of each tool.

End scrapers are common on blades and blade-like flakes. Evidence of hafting may be easier to identify on end scrapers on blades with unmodified lateral margins than retouched flake edges; it is possible that at least some end scrapers on flakes were hafted as well. The relatively smooth dorsal and ventral surfaces on blades may have been desirable for hafted end scrapers, which could have easily been replaced once the edge was expended. The side scraper and end-side scraper do not exhibit clear evidence of hafting.

Approximately 87.5% of the C1 scrapers were used on harder materials (Table 8). This may indicate that scrapers, particularly end scrapers, in this collection were used for more intensive tasks (involving harder materials) than bifacial tools sampled from C2. All of the hafted end scrapers exhibit edge damage indicative of harder material types.

Table 8. C1 Scraper sample.

<i>Morphology</i>	<i>Raw Material</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Range of Materials Worked</i>	<i>Hafted</i>	<i>Multifunctional</i>
end scraper	chert	yes	1	scrape	medium-hard, hard	yes	unknown
end scraper	chert	yes	1	scrape	medium-hard, hard	unknown	unknown
end scraper	chert	yes	1	scrape	medium-hard, hard	yes	unknown
side scraper	basalt	yes	2	scrape	medium-hard, hard	unknown	unknown
end-side scraper	chert	yes	1	scrape	soft, soft-hard	unknown	unknown
end scraper	undetermined	yes	1	scrape and cut	medium-hard, hard	yes	yes
end scraper	chert	yes	1	scrape and cut	medium-hard, hard	yes	yes
end scraper	chert	yes	1	scrape and cut	medium-hard, hard	yes	yes

There are seven scrapers within the C2 sample. Like the bifacial tools sampled from C2, the formal scrapers from C2 are more variable than the scrapers from C1. The C2 sample includes three side scrapers, two convergent scrapers, one end scraper, and one pointed side scraper. Approximately 71.4% of the scrapers in this sample exhibit signs of utilization, which is significantly higher percentage than the total sample of bifaces at 46%.

Approximately 29% of the C2 scrapers are multifunctional, which is similar to the scrapers sampled from C1. Like end scrapers from C1, at least two scrapers from C2 were used both as a scraper and a knife. The single end scraper from C2 is functionally similar to the side end scraper from C1. The end scraper in C2 exhibits two utilized elements; one at the distal margin, and another along the left lateral margin. The left lateral margin of the end scraper exhibits alternating bifacial feather, snap and occasional hinge fractures along the utilized edge indicative of bi-directional sawing through a soft to soft-hard material. The side scraper has one continuous utilized element exhibiting cutting and scraping activities. This is indicated by the presence of medium-sized unifacial hinge fractures that are interrupted by a crushed edge. The

remaining scrapers appear to have functioned primarily as scrapers, not scraper-knives. However, any of the scrapers could have been utilized as knives, if needed.

One major difference between the C1 and C2 sample of scrapers is that none of the scrapers from C2 appear to have been hafted (

Table 9). The scrapers sampled from C2 do not appear to have been used on any specific material. Of the utilized scrapers, three (60%) were used against medium-hard to hard materials, while two (40%) were used on softer materials. However, these number are slightly skewed since the end scraper, the convergent scraper, and the pointed side scraper were used on both soft and hard materials.

Table 9. C2 Scraper sample.

<i>Morphology</i>	<i>Raw Material</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Range of Materials Worked</i>	<i>Hafted</i>	<i>Multifunctional</i>
end scraper	rhyolite	yes	2	scrape and saw	soft and hard	unknown	yes
side scraper	argillite	yes	1	scrape	medium-hard, hard	unknown	unknown
side scraper	basalt	yes	1	scrape	medium-hard, hard	unknown	unknown
convergent scraper	rhyolite	yes	3	scrape	soft and hard	unknown	unknown
pointed side scraper	quartzite	yes	2	scrape	soft and hard	unknown	unknown
side scraper	quartzite	unknown	n/a	n/a	n/a	unknown	unknown
convergent scraper	basalt	unknown	n/a	n/a	n/a	unknown	unknown

The sample of formal scrapers was utilized more frequently than bifacial tools in both components. Approximately 87.5% of the sample of formal scrapers from C1 and C2 were utilized, compared to approximately 42.8% of complete bifacial tools. The C1 and C2 sample of scrapers consists of 15 artifacts. The C1 sample of scrapers consisted of: six end scrapers, one end-and-side scraper, and one side scraper. The C2 sample consisted of: three side scrapers, two convergent scrapers, a pointed side scraper, and an end scraper. Approximately 62.5% of the C1

sample of scrapers exhibit hafting signatures. Additionally, all of the identified hafted scrapers are end scrapers (there is only one end scraper in the C2 sample). None of the scrapers sampled from C2 exhibit clear hafting wear and were possibly only hand held, when utilized.

Unifacially worked scrapers (from both components) were used more often on resistant materials than on softer materials. However, three of the C2 scrapers exhibit a second utilized edge indicative of working a softer material (Table 9). Only one scraper from C1 was used on a softer material. An overwhelming majority of the C1 scrapers (87.5%), all of which are end scrapers, were used to work hard materials. All of the hafted end scrapers from C1 suggest use on more resistant materials. Given that hafting limits the angle at which a scraper is effective (Nissen and Dittmore 1974), it is possible that hafted end scrapers served a more specific purpose than non-hafted end scrapers. In contrast, all of the C2 hafted bifacial knives appear to have been used on generally soft materials. Given the differences between the C1 and C2 sample sizes, the scrapers from C1 were primarily used on harder materials, while scrapers from C2 were used slightly more on hard materials, while three of these scrapers have a second utilized element that suggests dual use on softer materials.

Worked unifacial tools within the Nenana and Denali sample had more than one function. Unifacial tools from both components were occasionally used as knives for cutting/sawing purposes. Approximately 37.5% of the utilized scraper sample from C1 were used for scraping and cutting activities, all of which are endscrapers. Only one scraper from C2 may have been multifunctional. The single end scraper from C2 was used to scrape and cut by using two utilized elements (Table 9), while the multifunctional end scrapers from C1 only had one utilized element (Table 8).

Blades

Six blades and one blade fragment were sampled from C2 (Table 10). There are not any blades within the C1 assemblage; however, many of the end scrapers from C1 were made on blades. There is a single blade-like flake from C1 that is reported in the next chapter on debitage. All of the sampled blades exhibit unmodified edges, making identification of wear patterns easier than on retouched bifaces and scrapers.

Of six blades, 42% appear to have been utilized. Of the utilized blades, none appears to have been used for anything other than light cutting. None of the blades shows clear signs of

prehension. All of the utilized blades were used as expedient knives to cut or saw through yielding materials. Edge damage on utilized blades typically occurs along one or both lateral margins of the tool. This may indicate that a relatively long and straight edge was desirable for expedient cutting purposes of a softer material. Approximately 67% of the utilized blades have two utilized elements. The blades with two utilized elements may indicate a relatively extended period of use of the tool prior to discard. There is at least one bifacial knife fragment from C2 that was made on a blade and it appears that blades were manufactured as blanks for bifacial tools within C2 instead of scrapers. The blade sample indicates that discarded unmodified blades were occasionally useful for expedient cutting purposes.

Table 10. C2 Blade sample.

<i>Accession No.</i>	<i>Raw Material</i>	<i>Morphology</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Materials Worked</i>	<i>Hafted</i>
73-0010	rhyolite	blade	yes	1	scrape	unknown	unknown
76-0012	basalt	blade	yes	2	saw	soft-hard, medium-hard	unknown
77-0367	rhyolite	blade	yes	2	saw	soft, soft-hard	unknown
73-0026	basalt	blade	unknown	n/a	n/a	medium-hard, hard	unknown
77-0495	chert	blade	unknown	n/a	n/a	medium-hard, hard	unknown
77-0607	chert	blade	Unknown	n/a	n/a	soft-hard, medium-hard	unknown
73-0009	rhyolite	blade fragment	unknown	n/a	n/a	n/a	unknown

Informal Tool Results

There are 72 unmodified flakes, retouched flakes, utilized flakes, blade-like flakes, large flakes, and burins within the informal tool sample. Of the sampled artifacts, 14 (19.4%) are from C1, while 58 (80.6%) are from C2. The estimated utilization rate of all flake tools is 66.7%. Like the sample of complete bifaces and scrapers from C2, the flake tools selected from C2 are more variable than the flake tools that were sampled from C1. This is mostly because of the variety of flake burins and burinated microcores found within C2, but not in C1.

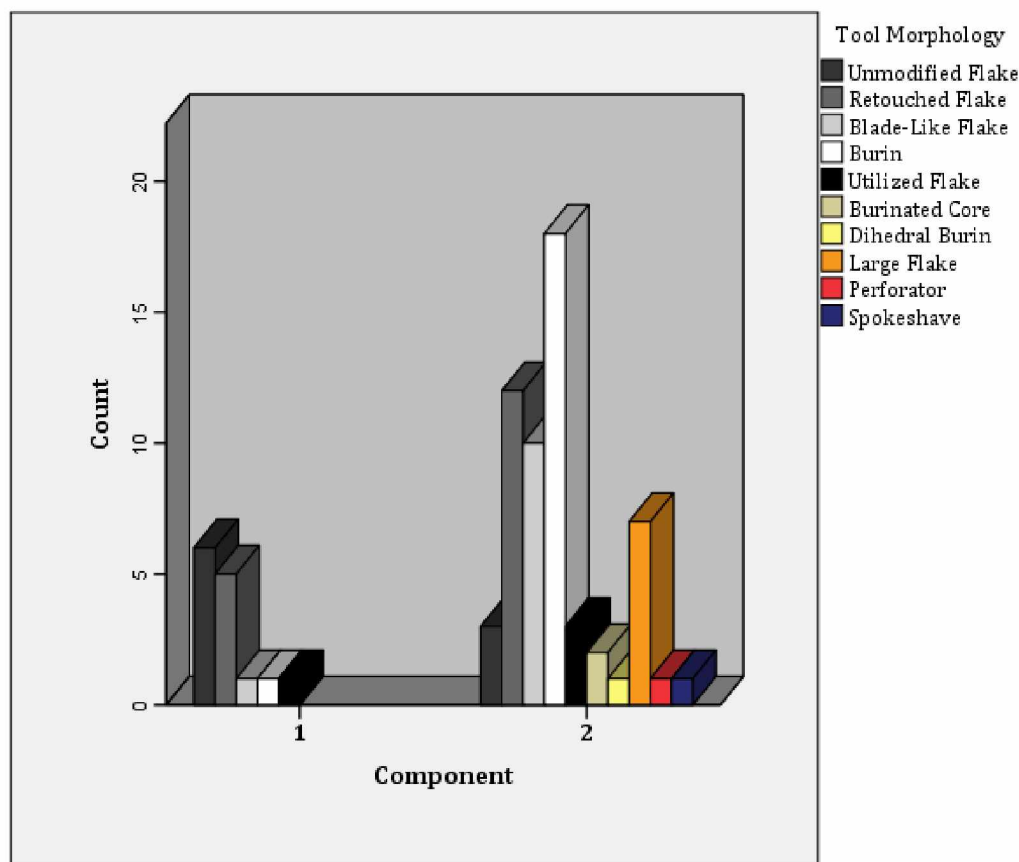


Figure 9. Informal tools sampled from C1 and C2.

Approximately 85.7% of the flake tools sampled from C1 exhibit signs of use, while 62.1% of the sample from C2 were utilized. Though there appears to be a large difference in the utilization rate between both components, the difference is not as significant as the difference between formal tools. This may indicate that flake tools may have been utilized more frequently than formal tools in both components, which might conserve tool edges and extend the use-life of finished bifaces and scrapers.

Retouched Flakes, Unmodified Flakes, and Utilized Flakes

The difference in the utilization rates between C1 and C2 samples of retouched flakes, utilized flakes, and unmodified flakes is not that great, approximately 83.3% of the sample from C1 exhibits usewear, while approximately 70.6% of the flakes from C2 were utilized. Four flakes were previously catalogued as utilized flakes and they do indeed appear to have been utilized. Approximately 76.5% of the retouched flakes exhibit signs of utilization. This is interesting since

retouched flakes tend to be thought of as tools, though a flake may be retouched for other reasons besides its use as a tool (Odell 1981).

As previously mentioned, all of the utilized flakes sampled from C1 and C2 do appear to have been utilized. This may be because utilized flakes within this sample do not exhibit retouched edges making utilization easier to identify at the macroscopic level. Approximately 62.5% of the unmodified flakes within this sample exhibit signs of utilization as well. Like utilized flakes, the flakes within this sample do not exhibit retouched edges on the utilized margin. Two of the flakes within the utilized unmodified flake sample exhibit flake scars less than 1 mm. Three of the utilized unmodified flakes have microflaking scars between 1-2 mm. However, a majority of the utilized flakes exhibit flake scars between 2-4 mm, which makes identifying signs of utilization easier to the un-aided eye. These data initially suggest that many discarded waste flakes that appear unmodified may still have been utilized for expedient purposes, especially if utilized flakes or retouched flakes are also associated with unmodified flakes of similar dimensions and edge angles.

There are 12 flakes in the C1 sample. Of these, 10 (83.3%) exhibit signs of utilization. None of the flakes in the C1 sample appear to have been hafted; they were likely hand-held, and utilized for a brief period. All of the utilized flakes in the C1 sample appear to have been used as scrapers and/or knives. The data show a slight preference to use C1 flake tools for scraping activities, given that 6 (60%) of all utilized flakes were used at least once as a scraper. The two “utilized” flakes were used as a scraper, or a knife. Only one unmodified flake may have been multifunctional and was used for scraping and cutting activities. One item (76-4278) exhibits unifacial perpendicular hinge fractures on an isolated utilized element that are indicative of scraping relatively medium hard to hard materials. The hinge fractures on the same element are crushed, indicating that the edge was utilized in a bidirectional cutting motion as a knife. Another flake scraper (76-1465) has two utilized elements involving two different material types, possibly for two different activities. One of these elements was used as an end scraper on a more resistant material, while the surface of the left lateral margin is well-roughened which is indicative of cutting or possibly scraping, softer materials.

The flakes within this sample appear show a slight shift towards softer material types (Figure 10). Approximately 50% of the tools suggest use on relatively soft materials, while approximately 40% of the sample suggests use on harder material types. The utilized flakes

within this sample generally appear to have been involved with similar materials as bifacial knives. It is possible that flake tools were strategically used in place of bifacial knives during butchering activities, as a way to extend the use-life of finished and especially hafted tools that are more time consuming to construct.

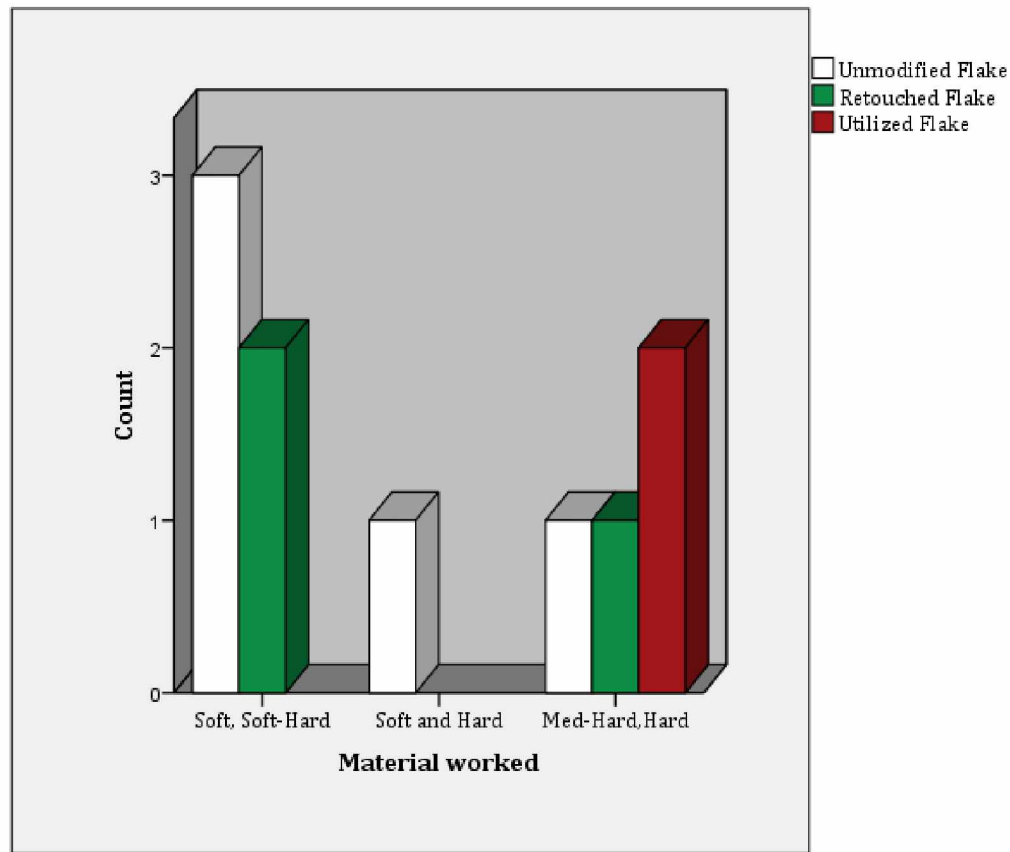


Figure 10. Relationship between flake morphology and relative material worked of flake tools sampled from C1.

Table 11. Utilized retouched flakes, utilized flakes, and unmodified flakes sampled from C1.

<i>Morphology</i>	<i>Raw Material</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Range of Materials Worked</i>	<i>Hafted</i>	<i>Multifunctional</i>
unmodified flake	chert	2	end and side scraper	soft and hard	unknown	possible
retouched flake	chalcedony	1	side scraper	med-hard, hard	unknown	unknown
unmodified flake	chalcedony	1	side scraper	soft, soft-hard	unknown	unknown
unmodified flake	rhyolite	1	end scraper	soft, soft-hard	unknown	unknown
utilized flake	chert	2	side scraper	med-hard, hard	unknown	unknown
retouched flake	rhyolite	1	side scraper	soft, soft-hard	unknown	unknown
utilized flake	chert	2	side scraper	med-hard, hard	unknown	unknown
retouched flake	chalcedony	2	cut and saw	soft, soft-hard	unknown	unknown
unmodified flake	chert	1	cut	soft, soft-hard	unknown	unknown
unmodified flake	chert	2	cut	med-hard, hard	unknown	unknown

There are 17 flakes within the C2 sample, which consists of 13 retouched flakes, two unmodified flakes, and two utilized flakes. Of these, 12 tools (70.6% of the sample) were utilized (Table 12). This includes 10 retouched flake and two utilized flakes that were already classified as utilized. There also appears to be a preference towards utilizing flakes, especially retouched flakes, as miniature side or end scrapers. A majority (75%) of the C2 sample was primarily used for scraping activities. Of the utilized flake scrapers, 88.9% are retouched flakes. There is at least one flake that may be multifunctional (exhibiting evidence of scraping and cutting/sawing motions on two utilized elements). At least two flakes exhibit edge damage patterns that are indicative of use during bidirectional cutting, or sawing purposes.

Approximately 75% of the utilized flake edges in the C2 sample indicate use on harder materials. For instance, 77.8% of the flake scrapers are hypothesized to have been used against more resistant materials, as was the single flake knife. Two flake scrapers appear to have also been utilized as knives. One flake scraper was used against a more resistant material, while the other was utilized on softer, more yielding materials. As with the sample from C1, none of the flakes appears to have been hafted and were likely hand held and used for expedient purposes.

There is a relatively even mix of flakes from C2 that were utilized as either an end scraper or a side scraper. Given the decline in the percentage of formal scrapers in C2 when compared to C1, it is tempting to hypothesize that expedient flake scrapers and knives could be utilized at times in place of more expensive formal tools. This may be to extend the use lives of scrapers and knives as well as reduce the need to construct or transport them as well.

Table 12. Utilized retouched flakes, utilized flakes, and unmodified flakes sampled from C2.

<i>Morphology</i>	<i>Raw Material</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Location of Wear by Margin</i>	<i>Activity</i>
retouched flake	basalt	yes	1	left medial and left distal	scrape
retouched flake	chert	yes	2	right lateral, left distal	scrape and cut
retouched flake	chert	yes	1	right distal	scrape
retouched flake	chert	yes	2	proximal, distal	scrape
retouched flake	chert	yes	1	left	scrape
retouched flake	chert	yes	1	distal	scrape
retouched flake	chert	yes	2	left, right distal	scrape
utilized flake	chert	yes	1	left lateral	scrape
retouched flake	chert	yes	2	left lateral, right proximal	saw
utilized flake	jasper	yes	2	left	saw
retouched flake	rhyolite	yes	1	right lateral	scrape
retouched flake	rhyolite	yes	1	distal	scrape

Blade-Like Flakes

Blade-like flakes are presented separate from retouched and utilized flakes in order to highlight how they may have been utilized at Dry Creek. Powers et al. (1983) hypothesized that

some blade-like flakes may have been utilized as tools and the results presented here indicate that they were. There are 11 blade-like flakes within the combined C1 and C2 sample. A majority of the blade-like flakes (72.7%) exhibit unmodified edges, while two blade-like flakes exhibit either unifacial or bifacial retouched edges. Given that 10 of the blade-like flakes were sampled from C2, and only one was sampled from C1, both components are combined into one discussion.

There are five utilized blade-like flakes in the sample (Table 13). The utilization frequency of blade-like flakes is estimated to be 45.5%, slightly less than half of the entire sample. All of the utilized blade-like flakes were used on softer materials (Table 13). The single artifact from C1 (77-3509) has a single utilized element that indicates it was used as a side scraper. Only one other blade-like flake (76-3021) was used as a side scraper. (Table 13). The sample of utilized blade-like flakes suggests that these tools mostly functioned as expedient knives. Approximately 80% of utilized blade-like flakes were used as knives to cut or saw through relatively soft materials (Table 13).

Table 13. Utilized blade-like flakes sampled from C2 and C1.

<i>Morphology</i>	<i>Raw Material</i>	<i>Component</i>	<i>Number of Utilized Elements</i>	<i>Activity</i>	<i>Range of Materials Worked</i>	<i>Hafted</i>	<i>Multifunctional</i>
blade-like flake	chalcedony	2	1	cut	soft, soft-hard	unknown	unknown
blade-like flake	basalt	2	2	saw	soft, soft-hard	unknown	unknown
blade-like flake	quartzite	2	2	saw	soft, soft-hard	unknown	unknown
blade-like flake	quartzite	2	2	side scraper	soft, soft-hard	unknown	unknown
blade-like flake	chert	1	1	side scraper	soft, soft-hard	unknown	unknown

None of the utilized blade-like flakes shows clear signs of having more than one function, or activity, though each tool was used either as an expedient knife or a scraper. Utilization typically appears along the right and left lateral margins of the flake, which is similar to blade tools. Overall, the wear on unmodified flakes is lighter than the wear patterns on retouched and utilized flakes. The lightness of the wear may be indicative of expedient fairly short-term use against softer materials.

The artifacts within the informal tool sample were previously classified as retouched flakes, utilized flakes, unmodified flakes, and burins. There are 72 artifacts within the sample of informal tools. This includes 14 specimens sampled from C1, and 58 from C2.

It is estimated that 85.7% of the C1 sample of tools were utilized, while approximately 62.1% of the C2 sample were also utilized. The results initially suggest that the percentage of utilized informal tools within C1 is also higher than the informal tools selected from C2, however the C2 informal tool sample is nearly four times larger than the C1 sample. If burins are removed from the sample and only retouched flakes, utilized flakes, and unmodified flakes remain, then the difference between the C1 and C2 informal samples is smaller (83.3% for C1, and 70.6% for C2).

Of the 17 flake tools sampled from C2, 12 (70.6%) appear utilized. A majority of these tools (75%) were used at least once as a scraper, which is slightly higher than the C1 sample of 60%. Almost 90% of the C2 flake scrapers are retouched flakes, which were used as either end scrapers or side scrapers. There are two additional utilized flakes within C2 that have a second element used as a knife. A majority of the C2 flake scrapers (77.8%) were used against fairly hard materials. The two flake scrapers with utilized knife edges came in contact with both hard and soft materials.

There is a relatively even mix of flakes in the C2 sample that were utilized as either end scrapers, or side scrapers (similar to flake tools in C1). Given that there is a decline in the percentage of formal scrapers in C2 (in comparison with C1), it is tempting to hypothesize that expedient flakes were utilized in their place, when possible. This may have extended the use of formal scrapers, as well as bifacial tools, preserving tool edges and reducing the need to construct and/or carry, some tools altogether, in certain situations.

Burins

There are 22 burins in the sample, 17 of which are burinated bifacial flakes, or flake fragments. The remaining artifacts consist of two burinated microcores, a burinated core tablet, a dihedral burin, and an atypical burin. One of the microcore burins was recovered from loess 2 (C1) of the Dry Creek Site and is tentatively included with the Nenana sample. Atypical burins and burinated scrapers have been previously associated with the Nenana complex (Goebel et al. 1991; Powers and Hoffecker 1989). Given that burinated tools are occasionally associated with

the Nenana complex, the loess 2 burin was included in the C1 sample in order to assess how burins may have been used at the site.

Out of 22 burins, 16 were utilized, which approximates 72.7% the total sample. Approximately 93.7% (n=15) of the utilized burins exhibit wear patterns that indicate working hard organic materials such as antler, bone, or, wood. This is what one would expect if burins were used to produce composite projectile points and point foreshafts out of hard organic materials (Anderson 1970a, 1970b; Giddings 1956; Guthrie 1983; Holmes 2011; Pétilion and Ducasse 2012; Potter 2005; West 1967, 1981). The utilized burins in the sample suggest that these tools were used for at least three different types of activities at the Dry Creek Site: (1) scraping, (2) engraving, and (3) sawing (Table 14). Most of the utilized burins were used as either a burin or a scraper. Burins used as scrapers typically exhibit utilization wear on the left or right lateral margin of the flake, not on the burin edge. Burin edges may have also functioned as miniature knives, for sawing, possibly for cutting a narrower groove into the worked material (Figure 12). Of the 16 burins that exhibit utilization signatures, 8 (50%) of the burins indicate primary use as a scraper or a knife. All but one of the burins exhibited a single utilized element on either the burinated edge or one of the side margins of the tool. Only one burinated flake is multifunctional in the sense that it has a utilized burin edge, and a lateral scraping edge (Table 14).



Figure 11. Unifacial scraping wear on the lateral margin of a burinated flake (15x)

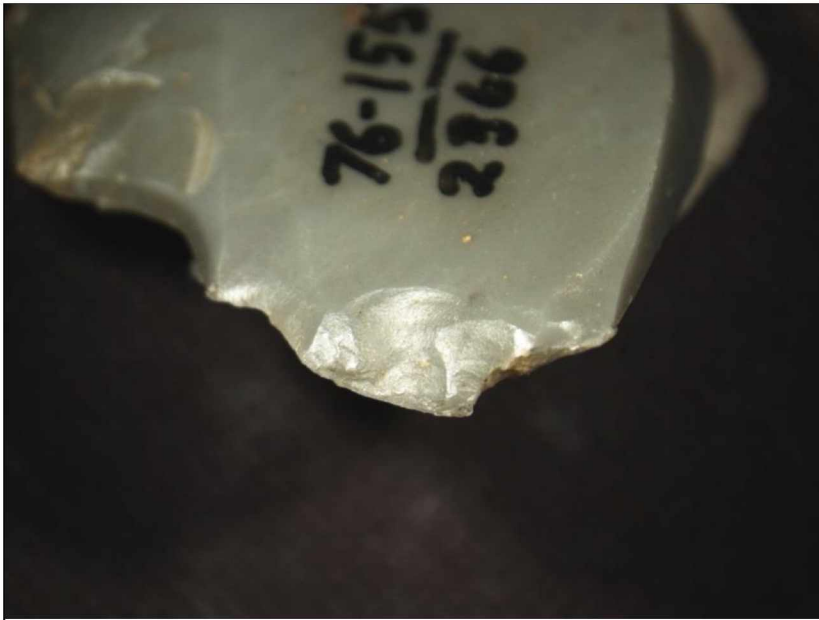


Figure 12. Burinated cutting edge of a microcore tablet from C2 (8x).

The degree of wear on utilized burinated edges ranges from heavy to less developed. The location of wear on burinated edges suggests that the left and right margins of the edge functioned as precise engraving tools. The burin sampled from C1 exhibits well-developed steep

and overlapping step fractures on the right and left corners of the burin edge (Figure 13). This type of edge damage is indicative of a fairly extended use on a particularly hard organic material such as antler, or possibly ivory. When burinated edges are wide enough for the required task, well-formed microwear patterns typically develop on one or both margins of the burin edge (Figure 14).



Figure 13. C1: Steep, overlapping hinge fractures on the right and left corners of a burinated flake (20x).



Figure 14. C2: Continuous overlapping hinge fractures on the right and left burinated edge of a flake (20x).

Table 14. Utilized burins.

<i>Morphology</i>	<i>Raw Material</i>	<i>Component</i>	<i>Utilized</i>	<i>Number of Utilized Elements</i>	<i>Location of Wear</i>	<i>Activity</i>	<i>Range of Materials Worked</i>
burinated flake	chert	1	yes	1	left proximal	engrave	medium-hard, hard
burinated flake	rhyolite	2	yes	1	right distal	engrave	medium-hard, hard
burinated microcore	chert	2	yes	1	right distal	engrave	medium-hard, hard
burinated core tablet	chert	2	yes	1	right distal	engrave/saw	medium-hard, hard
burinated flake	chert	2	yes	1	left distal	engrave	medium-hard, hard
burinated flake	chalcedony	2	yes	1	left distal	engrave	medium-hard, hard
burinated flake	chert	2	yes	2	right distal	engrave & scrape	medium-hard, hard
burinated flake	chert	2	yes	1	left distal	scrape	soft and hard
burinated flake	chert	2	yes	1	distal margin	scrape	medium-hard, hard
burinated flake	chert	2	yes	1	right lateral	scrape	soft, soft-hard
dihedral burin	chert	2	yes	1	left distal	scrape	medium-hard, hard
burinated flake	chert	2	yes	1	left proximal	scrape	medium-hard, hard
burinated microcore	chert	2	yes	1	distal	scrape	medium-hard, hard
burinated flake	chert	2	yes	1	distal	scrape	medium hard-hard
burinated flake	rhyolite	2	yes	1	left lateral	saw	medium hard-hard
burinated flake	rhyolite	2	yes	1	left distal	cut	medium hard-hard

Burins and Composite Tool Construction

Within the Denali Complex, the American Paleoarctic Tradition, and the Chindadn Complex tool kits, formal and functional analyses of burins indicate that they likely were used as

specialized tools with sharp corner edges that were used to construct composite projectile points with microblade insets (Anderson 1968; Cook 1969; Guthrie 1983; Potter 2005; Powers et al. 1983; West 1967). In one experimental study relating to the Dry Creek Site, Dale Guthrie (1983) used burins to manufacture a microblade inset point out of caribou antler. Using the burinated edge of a piece of glass, Guthrie cut grooves into a straight section of antler to extract a rectangular-shaped point preform. The antler was initially worked dry, but was soaked in water overnight to replicate the effects of it being freshly harvested. Fresh antler is softer than dry antler (e.g. Odell and Odell-Vereecken 1980). Guthrie found that the working the wet antler preserved the burin edge longer and made it easier to work. After three hours, a rectangular-shaped preform was removed and shaped into a point using a sharp edge of bottle glass as a scraper (Guthrie 1983:356). Once shaped, a burin was also used to cut a narrow 1 mm deep groove into the right and left lateral margins of the point for microblades. Though some burins may have been hafted (e.g. Anderson 1968), Guthrie (1983:255) hypothesized that the burins from Dry Creek could have “easily” been used without hafting. He also suggested the use of a hafted burin would apply a greater amount of pressure to the edge, causing it to break.

It has been frequently hypothesized that the fabrication of composite tools at the Dry Creek Site (and other sites in central Alaska) would have relied upon the availability of bone, antler, horn, and ivory (Anderson 1968; Giddings 1956; Potter 2005; Potter et al. 2014; Yesner 2001). When Dry Creek was initially inhabited (11,200 B.P.), the only local available wood would have been from varieties of shrub birch and willow, whose stalks are likely too flexible to use as composite points. Given that wood from birch, aspen, and spruce may not have been locally available until after 9,600 B.P. (Bigelow and Edwards 2001) we might expect that composite tools (as well as other tools used on generally harder materials) would reflect edge damage from the use of antler, bone, horn, and possibly scavenged ivory, instead of wood.

Utilized Burins

Of the 22 burins within the burin sample, 21 were sampled from C2 and one burin was sampled from C1. Burins are typically not part of the Nenana Complex (e.g. Powers and Hoffecker 1989). Burins on flakes are a technological feature of the Denali Complex (West 1967, 1981) and would not typically occur within known Nenana Complex assemblages (Easton et al. 2011; Powers and Hoffecker 1989). However, flake burins are associated with the Healy

Lake Chindadn Complex (Cook 1969, 1996). Regardless of whether the flake burin in the C1 sample is intrusive or not, its presence still contributes empirical data associated with composite tool construction and/ or maintenance in the lower components of the Dry Creek Site. The activities surrounding burins are fairly specialized, and appear to be oriented towards working very hard organic materials.

Lithic Raw Material Types

The Dry Creek terrace is located at the edge of a glacial outwash fan left by the Healy 1 glaciation, which dates to Illinoian or Early Wisconsinian in time (Ritter 1982; Ritter and Ten Brink 1986; Thorson and Hamilton 1977; Wahrhaftig 1958). Dry Creek once drained in front of the Healy Glacier, picking up alluvium and dumping it downriver in a 25 m thick layer near the site (Thorson and Hamilton 1977). The bed in front of the site is a known source of brown chert (Powers et al. 1983). Lower quality lithic materials such as quartz and schist, with lesser amounts of metasediments and volcanics are also available in the Dry Creek bed (Thorson and Hamilton 1977). The sources of additional cryptocrystalline materials such as chalcedony (and grey chert) are believed to be available locally (possibly from the Dry Creek bed itself) though a source is not yet known (Goebel 2011; Powers et al. 1983).

The Nenana River is the second known local source of raw materials. It is located approximately 2 km west of the site. The Nenana lode contains various assortments of volcanic and plutonic rocks that are mixed with high amounts of lithic sandstone, conglomerate, and quartz mica schist (Thorson and Hamilton 1977), providing a source of rhyolite, basalt, argillite, quartz, pumice, diabase, sandstone, slate, and schist (Powers et al. 1983). The most common lithic material type from the site is rhyolite, while the most common material in the tool sample is chert. There are various colored cryptocrystalline materials in the C1 and C2 samples including chert, chalcedony, argillite and jasper. Additional lower quality, coarser-grained materials include: pumice, sandstone diabase, slate, schist, and quartz (Powers et al. 1983). Obsidian is a common material type associated with microblade materials (Hoffecker 1983). Additionally, a broken late-stage triangular knife and several waste flakes made of devitrified volcanic glass are also reported in association with C1 (Powers et al. 1983).

The most common lithic material in the sample of tools from Dry Creek is chert followed by rhyolite, basalt, quartzite, and chalcedony. Out of 76 chert tools, 80.3% were utilized,

followed by rhyolite (n=34 [58.8% utilized]), basalt (n=31 [35.5%]), quartzite (n=17 [47.1%]), and chalcedony (n=7 [71.4%]) (Figure 15). Fine-grained materials were important for bifacial knives, projectile points, and scrapers (as well as utilized flakes) in both components.

All of the bifacial tools and fragments (and 71.4% of the scrapers) from C1 are made of chert. The only artifacts in the C1 sample of formal tools not made of chert are a single basalt side scraper and an end scraper of an unknown material type. Nine (64.2%) of the informal flake tools sampled from C1 are also made of chert. A wider variety of raw materials were used to construct bifacial and unifacial tools sampled from C2, than C1. Bifacial knives, projectiles, and fragments from C2 are either made of basalt (n=14), chert (n=14), rhyolite (n=12), and quartzite (n=8). Combined, these materials approximate 92.3% of the sample of bifaces and biface fragments. There is also a chalcedony biface, a biface of an undetermined material type, an obsidian point base, and an argillite knife blade fragment within the C2 tool sample.

Contrary to C1, none of the scrapers sampled from C2 are made of chert. Basalt, quartzite, and rhyolite each approximate 28.5% of the C2 scraper sample, along with a single argillite side scraper. However, chert (along with chalcedony) were used to construct scrapers not included in the C2 sample (Powers et al. 1983). Most of the lithic materials associated with the lower components (aside from obsidian and devitrified volcanic glass) are available locally (Goebel 2011; Powers et al. 1983; Thorson and Hamilton 1977). There are at least two local sources of lithic raw materials near the Dry Creek Site: the Dry Creek bed, and the Nenana River.

The occupants of C1 preferred to construct bifacial knives, projectiles, and scrapers from chert. Both brown and gray chert were used. While tool makers in C2 depended on basalt, chert, rhyolite, and quartzite to fashion bifacial tools and scrapers. Given that workable nodules of chert in the Dry Creek bed is a finite resource, it is possible good quality cherts became depleted through time and people turned to other local sources for stone tools. This scenario could explain why there is a greater ratio of chert tools in C1, versus C2. The Walker Road assemblage contains 13 types of chert, along with various types of chalcedony, argillite, quartzite, quartz, and undetermined (as well as two types of obsidian) (Goebel 2011). The debitage patterns and corresponding material types from Walker Road indicate an emphasis on primary and secondary reduction of local lithic raw materials (Goebel 2011). Ted Goebel also suggested that the former occupants of Walker Road arrived at the site empty-handed and, "...mined local toolstone from

around the site and used them exclusively to create a rather expedient-looking toolkit” (Goebel 2011:212).

Chert appears to be an important resource for manufacturing bifacial tools and scrapers in C1. No single raw material within the C2 sample was conserved for any particular function, however finer-grained basalts, cherts, and rhyolitic materials were all preferred for manufacturing bifacial and unifacial tools at the site. All of the lithic materials were utilized, though some were used more than others. A majority of chert tools and other cryptocrystalline silicates were utilized. The least utilized material type is basalt. Additionally, a proportion of proximal biface fragments made of basalt may have been hafted (Table 7). The frequent number of bifacial tools and fragments suggests that at least some of these tools may have been used, even though microwear signatures are not clearly visible on the blades. Utilized bifacial knives, and fragments from both components (approximately 75% of which were used on softer materials) also suggests that butchering knives often broke during use. The frequent presence of snap and hinge fractures on utilized bifacial knives may also indicate that these tools could have snapped after penetrating into, and cutting dense muscle and/or tendon tissue. Because butchering involves cutting into a variety of soft materials such as hides, meat, and organs, diagnostic microwear formations may not have had the time to develop prior to the tool being discarded, either from breaking, or from completion of the task at hand.

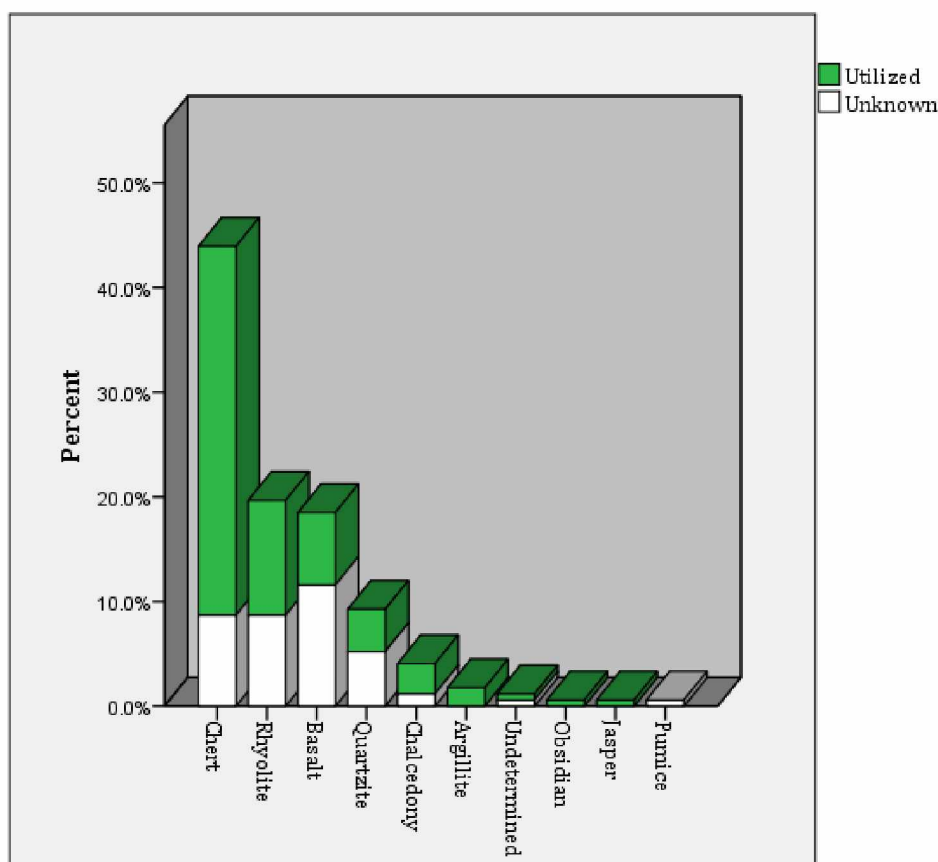


Figure 15. Utilized raw materials sampled from C1 and C2.

Secondary Modifications

Secondary taphonomic modifications of the artifacts along with the presence of potential residues on their surfaces highlights what secondary processes within the natural and cultural environments may have affected the preservation and distribution of microwear patterns on the tool assemblages. These variables also provide another level of comparison between the two components (Table 15).

Certain aspects of the local environment surrounding the site are used to infer what secondary processes may have altered the usewear patterns within the C1 and C2 samples. Secondary alterations of artifacts from the natural and cultural environments are known to affect the distribution and preservation of micro patterns on lithic tools (Rottländer 1975). The Dry Creek site lies within a region highly affected by advancing and retreating glacial activity during the Pleistocene, and early Holocene. Advancing glaciers in alpine settings produce strong katabatic winds that can erode landforms and alter the surfaces of exposed lithic materials, often

forming abrasions and polishes. The basal gravel at the site is comprised of Healy 1 outwash gravel. Prior to the deposition of aeolian sediments, the matrix of the Healy alluvium was exposed for an extended period and subjected to wind abrasion, frost shattering, oxidation, and carbonate weathering (Thorson and Hamilton 1977:173). The presence of these surface modifications helps to differentiate between Healy alluvium from other outwash lodges in the region that were immediately covered by an outwash fan laden with sediments (Ritter and Ten Brink 1986; Thorson and Hamilton 1977). The Healy outwash differentiates from Riley Creek outwash based on the presence of fractures, wind polish, ventifacts, oxide staining, and carbonate encrustations (Thorson and Hamilton 1977:172). There are similar variables on a number of tools in the sample. There is a clear white patina, similar to carbonate, on a number of artifacts from both components. Carbonate is a common element within the environment at the site. A 1 cm carbonate layer was found on the undersides of cobbles near the bluff edge (Thorson and Hamilton 1977). Fine amounts of carbonate were only detected in the lower 50 cm of loess 3 (C2) (Thorson and Hamilton 1977). If the patina is carbonate it may further indicate artifact mixing between the two components, given that carbonate was only detectable in C2 (Thorson and Hamilton 1977, Thorson 2006).

Many of the artifacts in the sample also exhibit variable signs of oxidation. The oxidized materials likely originated from natural processes and cultural activities. Iron oxides within the soil, and possibly wildfire, have contributed to the oxidation of some of the artifacts. While human activities, such as preheating or firing tool stone prior to lithic reduction, may have also been a factor. The sedimentary units of the Dry Creek Site contain high levels of oxidized iron particles. The highest concentration of iron oxide particles were found in loess units 2-6 (Thorson and Hamilton 1977). Oxidized patinas have also formed on the surface of Healy outwash. The oxidation (and the wind polish) of the Healy outwash were hypothesized to have formed under intense periglacial conditions (Thorson and Hamilton 1977). In order to gauge whether an artifact was oxidized prior to manufacture, the ventral surfaces and surfaces of flake scars were compared to the outer surfaces. If oxidation occurred within the scar or the ventral surface of a flake it was assumed to have been oxidized after manufacture, if oxidation does not occur in these areas, it was assumed that the lithic material was oxidized prior to manufacture, given that the oxidized surface areas would have been flaked away during reduction.

Table 15. Taphonomic signatures identified on the tool sample.

<i>Component</i>	<i>Oxidized</i>	<i>Frost Cracks</i>	<i>Sheen</i>	<i>Possible Carbonate</i>
1	n=18 (62.1%)	n=4 (13.8%)	n=19 (65.5%)	n=5 (17.2%)
2	n=113 (78.4%)	n=4 (2.8%)	n=109 (75.7%)	n=33 (22.7%)
Percent of total Sample:	136 (79.1%)	8 (4.6%)	128 (73.5%)	38 (21.8%)

CHAPTER V: CONCLUSIONS

Research Hypotheses Revisited

This research project set out to compare the functional similarities and differences between Nenana and Denali formal and informal tools from C1 and C2 of the Dry Creek Site. In order to compare the tool kits, four research hypotheses were advanced in the introductory chapter: (1) C1 and C2 tools will exhibit similar types of utilization. (2) The C1 and C2 samples will have similar percentages of utilized tools; (3) form (formal tool types) and function are related; and (4) Dry Creek C1 and Walker Road (Flannigan 2002) usewear results are similar. Each hypothesis is individually assessed in the following section.

“C1 and C2 tools will exhibit similar types of utilization.”

C1 and C2 tools do exhibit similar types of utilization involving similar motions against similar material types. Formal scrapers analyzed from C1 and C2 primarily functioned as scrapers, as was expected, though some scrapers also exhibited use as cutting or sawing tools. Most of the utilized bifacial tools and fragments from the Nenana and Denali components primarily functioned as either projectile points or knives. At least three of the endscrapers from C1 exhibit a single utilized element exhibiting both scraping and cutting wear patterns. On the other hand, the single end scraper from C2 has two utilized elements, the distal scraping edge and a lateral cutting edge. A majority of the C1 endscrapers were hafted, while no definitive signs of hafting were observed on any of the analyzed scrapers from C2. Overall, scrapers from both components were used more often on denser harder materials such as bone or antler. Hafted bifacial knives from both components tended to exhibit use on softer materials, if they exhibited any wear at all.

A small number of bifacial knife tools from C2 were used for activities not found in C1. Less than 1% of bifacial knives from C2 exhibit lightly developed unidirectional shaving or scraping wear on one margin of the blade. This activity pattern was not identified on the small number of utilized bifaces in C1 tool sample. Two utilized bifacial knives from C2 (an ovate knife and a small spatulate knife) exhibit this scraping wear patterns. The variable flake scar

patterns along the utilized element of the blades are suggestive of use on mostly soft, but possibly hard materials. Lightly shaving and scraping meat off of bone in a downward straight or slightly curved direction during butchering may provide the best explanation of this type of wear pattern in the sample of utilized knives from C2. The use of bifacial tools as scrapers in C2 is highlighted by the presence of a single discoidal bifacial scraper that was used on a fairly harder material, like bone. Another outlier in C2 is a small projectile point that may have been used to engrave bone, or antler. Unilinear scraping, shaving, and engraving activities are not clearly represented on the C1 bifacial artifacts. Given that the Denali sample is nine times larger than the Nenana one, the absence of shaving wear on the single utilized bifacial knife and point two fragments from C1 is not especially significant.

“C1 and C2 tools have similar frequencies of utilized tools (intensity of use).”

The percentage of utilized tools is one of the biggest differences found between the C1 and C2 samples. Approximately 86% of the C1 tools were utilized, while 59% of the C2 tools exhibited signs of utilization. However, it was discovered that the frequency and intensity with which a tool was used is variable between bifacial knives and formal scrapers. Overall, utilized scrapers from both components tend to exhibit better, well developed edge damage patterns than utilized knives. Formal scrapers show a higher frequency of use on harder materials when compared to bifacial knives, regardless of component. Given that the ratio between scrapers and bifacial tools in C1 is much higher than in C2, the significantly greater percentage of utilized tools in the Nenana sample is likely due to activities associated with scrapers, particularly end scrapers. Additionally, the lower percentage of utilized artifacts in the Denali component is a reflection of the higher number of bifacial tools over scrapers in C2. This suggests that the formal technological variability that is expressed between the Nenana and Denali components at Dry Creek is a result of the activities associated with the tools in each assemblage, versus having been manufactured by people representing two historically isolated cultural traditions.

“Form (formal tool types) and function are related.”

This is true for some tools such as scrapers, which are loosely affiliated with function, while bifacial tools are not, which could be used as projectiles, knives, scrapers, and possibly engravers. As expected, formal scrapers sampled from C1 and C2 primarily functioned as

scrapers, even if they were used as cutting tools. There are also a number of projectile point bases in each component, which indicates that point shafts were considered to be valuable and were recovered from the field and brought back to camp to be retooled. Projectile points from both components may have been designed to break as well. This would allow the detached blade to bury itself deeper into a fleeing animal, as well as enable the quick retrieval of the shaft at the location of impact.

“Dry Creek C1 and Walker Road C1 (Flannigan 2002) usewear results are similar.”

There are similarities and differences between the Dry Creek and Walker Road studies. Approximately 84.2% of the Walker Road sample was utilized, while 86.7% of the C1 Dry Creek sample was utilized. Both assemblages contain a high number of scraping tools over bifacial tools. However, at Walker Road, 93% of the utilized tools were used as scrapers, while only 52% of all the utilized tools sampled from Dry Creek C1 functioned as scrapers. Flannigan (2002) reported that a majority (64%) of the scraping tools were used to scrape soft animal hides. On the other hand, approximately 67% of the Dry Creek formal and informal scraping tools were used on a more resistant material type, such as bone or antler. The Walker Road cutting tools were fairly evenly used to cut or saw both soft and hard materials. A similar pattern was found at Dry Creek with roughly 55% of the cutting tools were used on softer versus hard material types.

Functional Attributes of the Dry Creek Nenana and Denali Tool Kits

Reaching beyond formal definitions of the Nenana and Denali complexes, it was found that tool form and function between the Dry Creek Nenana and Denali samples are loosely related. Some formal tools such as scrapers are more closely related to function, while bifacial tools are not. Bifacial tools had several functions, including use as knives, projectile points, and occasionally as scrapers. Even though formal tool types were generally used for the same types of tasks, there are functional indicators associated with the sample of artifacts from the Dry Creek Nenana and Denali tool kits. It is hypothesized in this thesis that the Dry Creek Nenana and Denali lithic tool assemblages primarily revolved around completing one of two general types of tasks relating to what Binford and Binford (1966) previously defined as maintenance activities and extractive activities. Extractive activities relate to harvesting subsistence goods and raw material resources from the surrounding environment (Binford and Binford 1966; Bousman

1993, 2005). Extractive tools are used for hunting and butchering activities, gathering plants, or procuring raw toolstone from quarries (Binford and Binford 1966). Maintenance tools are generally used at a base camp to process available goods for redistribution, consumption, and tool manufacture.

The poor preservation of faunal remains from the Dry Creek Site provides a somewhat limited picture of what animals were likely hunted near the site. All of the identifiable faunal remains from C1 and C2 are primarily based on tooth remains; recovered bone fragments from both components are degraded and not useful for identifying species (Powers et al. 1983). The identifiable faunal remains from C1 are sheep and elk, while remains associated with C2 have been described as sheep and bison (Powers et al. 1983). Ethnoarchaeological studies with Nunamiut populations of the Alaskan Brooks Range demonstrate how larger animals, such as a caribou, are butchered and processed after one or more are killed (Binford 1978). Butchering of large animals by modern subsistence oriented populations occurs in several episodes beginning once an animal is killed and ending after their remains are completely processed, consumed, and discarded. Binford (1978:48) distinguished between *primary* (field butchering) and *secondary* (at cache) butchering activities. Nunamiut field butchering practices generally involve using knives to cut the head and legs off of caribou during primary butchering activities. Cutting tools are useful to slice through abdominal muscles in order to remove the organs. Binford (1978) also noted that the Nunamiut hunters would cut an animal in half with a knife by severing its back below the last thoracic vertebrae. Depending on transport considerations, and the number of people in the hunting party, the anatomical parts of the animal are reduced to more portable units and brought back to a base camp for additional processing. Once the remains arrive at the base camp maintenance tools are used to redistribute meat for consumption and process extracted raw materials from the remains, such as bone, antler, or hide, into tools or other useful items (Binford and Binford 1966; Binford 1978, 1980; 1984; Lupo 2001; O'Connell et al. 1988; 1990; 1992; White 1952, 1953).

Overall, the functional attributes identified on bifacial tools from C2 may suggest that the Dry Creek Denali assemblage of formal tools may have primarily functioned as an extractive tool kit for hunting and primary/early stage butchering activities. The identifiable utilization signatures on C2 bifacial knives, projectile points, and tip fragments are fairly lightly developed when compared to unifacially worked scraping tools and utilized flakes. The sample of utilized

bifacial knives and fragments from C2 tended to be used on generally soft versus hard materials. All of the utilized hafted knives appear to have been used on softer materials. These types of wear patterns may develop on knives and knife fragments used for early stage butchering tasks involving cutting through softer neck and leg muscles, eviscerating stomach contents, and cutting through tendons and hard materials such as leg and spinal joints in order to subdivide the anatomical parts of the animal into smaller packages for transport to a more permanent or long term base camp for storage. Skinning the animal and cutting or shaving meat from bone during primary and secondary butchering activities may also explain some of the wear patterns on utilized knives from C2.

The relatively high frequency of utilized C2 bifacial knife fragments suggests that microwear distributions on bifacial knives are relatively poorly developed because knives frequently snapped while in use and were replaced with a new tool instead of being fixed or recycled for another purpose (Bamforth 1986). Utilized projectile points may have also been replaced if they were determined to be too damaged. Overall, projectile points are extractive tools that were likely used as weapons for fatally wounding game during hunting expeditions. Projectile points often snapped into two or more fragments as the result of shock waves traveling through blade upon impacting its target. Utilized projectile points don't always snap on impact; sometimes their tips were damaged from impact as well. Even though bifacial points with damaged tips may not have been completely useless, the point foreshafts from C1 and C2 were likely retooled with a functioning point, possibly to limit the risk of failure while hunting (Bamforth and Bleed 1997; Bousman 2005; Kuhn 1989; Torrence 2001). The presence of utilized bifacial knife and point fragments associated with discarded miscellaneous bifacial preforms, and thousands of various sizes of primary and bifacial flakes of locally available lithic materials also suggests a large number of extractive tools were manufactured on site by one or more groups of early Alaskan hunter gatherers (Goebel 2011; Smith 1985). Bifacial tool production is also associated with the Nenana assemblage at Dry Creek. However, based on the available evidence, the manufacture and use of bifacial tools in C1 was nowhere near the degree seen in C2. The hypothesis that the Dry Creek Denali tool kit primarily functioned as an extractive tool kit for hunting and earlier stage butchering activities may be even more significant if microblades were included in this analysis. There are approximately 1,800 microblades associated with the C2 tool assemblage that were left out of the sample (Powers et

al. 1983). Microblades may also be considered as extractive tools since they were inset along the lateral margins of hard organic projectile points manufactured from antler, bone, or ivory (Guthrie 1983; Potter 2001).

If the Denali tool kit from Dry Creek was primarily manufactured and utilized as an extractive hunting and early stage butchering tool kit, the utilized formal tools from the Nenana component (C1) indicate that this assemblage may have primarily functioned as a maintenance or later-stage secondary butchering tool kit. The C1 scraper assemblage is dominated by endscrapers, most of which may have been hafted and were used on harder organic materials such as antler or bone. Ethnographic studies and experimental usewear analysis of endscrapers often associates endscraper use by women for hide work (Hayden 1986; Takase 2011; Weedman 2006). However, the C1 sample of scrapers suggests later stage butchering practices that may have involved processing hard organic materials (e.g. antler, ivory, or bone) into composite tools such as projectile points, point foreshafts, or knife handles. The predominance of later stage butchering practices in C1 may also be indicated by the difference of utilization signatures between the sample of Nenana and Denali formal tools. The Nenana tool sample exhibits well-developed usewear patterns that indicate unifacial scrapers may have been utilized for more extended periods than bifacial knives, which would allow for the microwear to develop more evenly and make utilization wear patterns easier to identify on the blade of the tool. The presence of sheep and elk teeth associated with C1 and the fact that an overwhelming majority of C1 scrapers were used on harder organic materials suggests that antler, horn, and possibly bone were harvested from game to be processed into tools. In a similar study on the Nenana assemblage at Walker Road, Flannigan (2002) estimated that a majority of endscrapers sampled were used on softer materials such as hides, which may also indicate that the Walker Road Nenana Complex is primarily a maintenance or, later stage butchering/processing tool kit. Endscrapers are not always used on hides; they have also been documented as having been used to work a variety of hard and soft material types such as boned, hide, wood, and antler (Dumont 1983; Siegel 1984). The hypothesis that endscrapers from Dry Creek Nenana tool kit were also used as knives should not be too unusual given that endscrapers have been previously documented as scraping, chopping, engraving tools, and even as projectiles (Odell 1981). Previous studies have demonstrated that endscrapers and flake scrapers are useful for sawing and shaping hard organic materials such as

antler into projectile points or point foreshafts (Guthrie 1983; Pétillon and Ducasse 2012; Pétillon et al. 2011).

Both Goebel et al. (1991) and Buchanan and Collard (2008) have hypothesized that either the Nenana complex or the Denali complex are more closely related to Clovis than either are to each other. The author of the present study agrees that the Dry Creek Nenana and Denali tool assemblages are indeed different. As an alternate hypothesis for the origins of the Nenana Complex, Powers and Hoffecker (1989:278) suggested that Nenana Complex and Denali Complex lithic assemblages may have differing functional variables which would mean that both tool kits may be part of the same lithic tradition. It is hypothesized that the Dry Creek Denali tool assemblage may have primarily been manufactured and functioned as an extractive tool kit for hunting and early stage butchering activities, while formal tools associated with the Nenana component at Dry Creek may have primarily functioned as a maintenance tool kit for later stage butchering/processing activities.

Limitations

The results presented in the previous sections were used to generate tentative hypotheses concerning functional similarities and differences between Nenana and Denali formal tool kits. This study lacked an experimental component that would compare observations of usewear on the Dry Creek sample to a replicated tool set. Given the significant amount of additional time such a project would involve, incorporating an experimental component into this study was not feasible. Additionally, multiple blind tests performed on experimental toolsets suggests that both low and high powered methods are reliable in identifying variables relating to the activities surrounding the use and taphonomic modifications of stone tools (e.g., Keeley 1980; Keeley and Newcomer 1977; Levi-Sala 1986; McBreaty et al. 1998; Odell and Cowan 1986; Odell and Odell-Vereecken 1980; Shea 2008; Tringham et al. 1974).

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APPENDIX A: CROSSTABULATIONS

Table 16. Estimated utilization rate of the sample of all formal and flake tools by component.

Component * Utilized Crosstabulation

		Utilized		Total
		no	yes	
Component	1. Count	4	26	30
	% within Component	13.3%	86.7%	100.0%
	2. Count	58	86	144
	% within Component	40.3%	59.7%	100.0%
Total	Count	62	112	174
	% within Component	35.6%	64.4%	100.0%

Table 17. Pearson chi-square table indicating that the frequency of utilized tools within the C1 and C2 tool sample are different.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.859 ^a	1	.005		
Continuity Correction ^b	6.728	1	.009		
Likelihood Ratio	8.935	1	.003		
Fisher's Exact Test				.006	.003
N of Valid Cases	174				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.69.

b. Computed only for a 2x2 table

Table 18. Frequency table showing the estimated utilization rate between C1 and C2 sample of formal tools.

Component * Utilized Crosstabulation				
Formal Tools		Utilized		Total
		no	yes	
Component	1.	Count	2	14
		% within Component	12.5%	87.5%
	2.	Count	36	50
		% within Component	41.9%	58.1%
Total		Count	38	64
		% within Component	37.3%	62.7%

Table 19. Pearson chi square test showing that the frequency of utilized formal tools between C1 and C2 are different.

Formal Tools	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.975 ^a	1	.026	.027	.021
Continuity Correction ^b	3.798	1	.051		
Likelihood Ratio	5.712	1	.017		
Fisher's Exact Test					
N of Valid Cases	102				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.96.

Table 20. Estimated utilization rate between informal tools by component.

Informal Tools			Utilized		Total
			no	yes	
Component	1.	Count	2	12	14
		% within Component	14.3%	85.7%	100.0%
	2.	Count	22	36	58
		% within Component	37.9%	62.1%	100.0%
Total		Count	24	48	72
		% within Component	33.3%	66.7%	100.0%

a. Computed only for a 2x2 table.

Table 21. Chi-square table indicating that the rate of utilized informal tools from each sample are not equal.

Chi-Square Tests Flake Tools

Informal Tools	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.837 ^a	1	.092		
Continuity Correction ^b	1.873	1	.171		
Likelihood Ratio	3.183	1	.074		
Fisher's Exact Test				.121	.081
N of Valid Cases	72				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.67.

b. Computed only for a 2x2 table

Table 22. Sample of C1 scrapers.

Morphology * Utilized Crosstabulation

C1 Formal Scrapers			Utilized	Total
			yes	
Morphology	end scraper	Count	7	7
		% within Utilized	77.8%	77.8%
	side scraper	Count	1	1
		% within Utilized	11.1%	11.1%
	end-side scraper	Count	1	1
		% within Utilized	11.1%	11.1%
Total	Count		9	9
	% within Utilized		100.0%	100.0%

Table 23. C1 scraper morphology and the variable multifunction.

Morphology * Multifunctional Crosstabulation

C1			Multifunctional		Total
			no	yes	
Morphology	end scraper	Count	4	3	7
		% within Multifunctional	66.7%	100.0%	77.8%
	end-side scraper	Count	1	0	1
		% within Multifunctional	16.7%	0.0%	11.1%
	side scraper	Count	1	0	1
		% within Multifunctional	16.7%	0.0%	11.1%
Total	Count		6	3	9
	% within Multifunctional		100.0%	100.0%	100.0%

Table 24. Utilization rate of formal scrapers sampled from C2.

Morphology * Utilized Crosstabulation

C2 Formal Scrapers			Utilized		Total
			no	yes	
Morphology	side scraper	Count	1	2	3
		% within Utilized	50.0%	40.0%	42.9%
	pointed side scraper	Count	0	1	1
		% within Utilized	0.0%	20.0%	14.3%
	end scraper	Count	0	1	1
		% within Utilized	0.0%	20.0%	14.3%
	convergent scraper	Count	1	1	2
		% within Utilized	50.0%	20.0%	28.6%
	Total	Count	2	5	7
		% within Utilized	100.0%	100.0%	100.0%

Table 25. Estimated utilization rate of blades.

Utilized?		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	4	57.1	57.1	57.1
	Yes	3	42.9	42.9	100.0
	Total	7	100.0	100.0	

APPENDIX B: FORMAL TOOLS



Figure 16. UA74-0296: Perpendicular unifacial hinge fractures on a side scraper (8x).



Figure 17. UA77-0005: Bifacial perpendicular non-overlapping snap and hinge fractures on a bifacial knife fragment (8x).



Figure 18. UA77-4654: Unifacial continuously overlapping perpendicular and isolated snap fractures on the edge of an end-side scraper (20x).



Figure 19. UA74-0068: Rounded non-overlapping snap fractures on a side scraper (10x).



Figure 20. UA74-0082: Continuous hinge fractures with rounded/eroded flake scar patterns on a quartzite side scraper (10x)



Figure 21. UA74-0094: Typical edge of a discarded bifacial preform fragment showing no indication of utilization (10x).

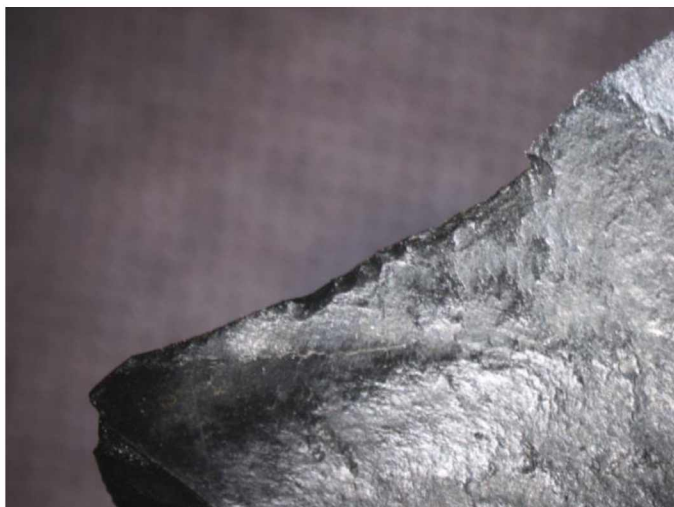


Figure 22. UA74-0189: Dorsal view of hafting wear, proximal left margin, on a utilized bifacial chert knife fragment (10x).



Figure 23. UA74-0189: Ventral view of hafting wear on proximal right margin (10x).



Figure 24. UA74-099: Smoothed and eroded flake scars on right margin of a rhyolite biface (30x).



Figure 25. UA74-0258: Eroded perpendicular to slightly oblique hinge fractures exhibiting surface sheen along the raised areas (20x).

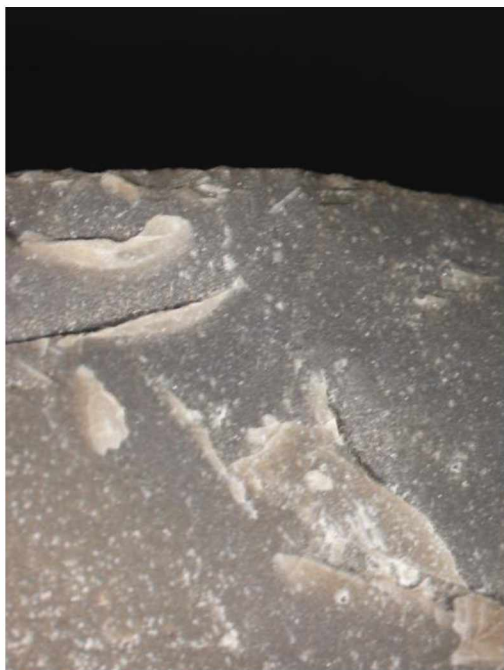


Figure 26. UA74-0265: Left proximal utilized margin of a side scraper (10x).



Figure 27. UA74-0265: Continuous perpendicular hinge and step fractures along the right margin (10x).



Figure 28. UA74-0267: Continuous small hinge fractures along the right lateral margin of a side scraper (10x).

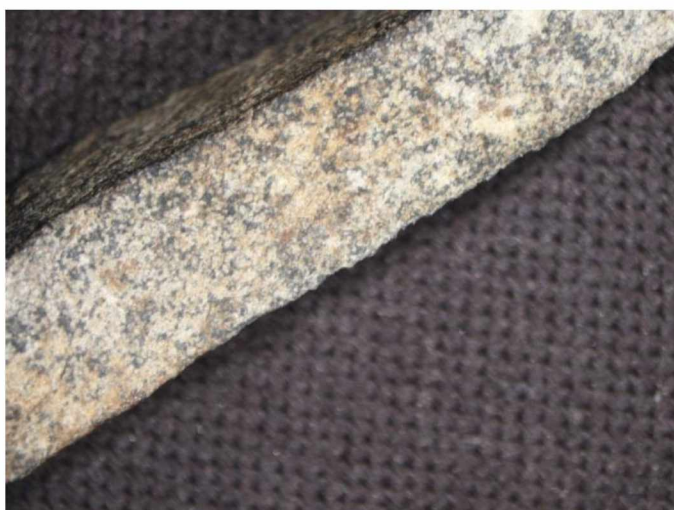


Figure 29. UA76-0012: Bifacial continuous and non-overlapping snap and hinge fractures on a refit blade suggesting bidirectional cutting of generally softer materials (8x).



Figure 30. UA76-0090: Well-rounded utilized edge on a bifacial knife fragment (10x).



Figure 31. UA76-0090: Polished edge at the proximal margin of a bifacial knife fragment (10x).



Figure 32. UA76-0148: Unifacial perpendicular hinge and small feather fractures on a possible spokeshave edge (20x).



Figure 33. UA76-0260: Continuous perpendicular hinge and feather fractures on a biface fragment (10x).



Figure 34. UA76-0302: Large to medium snap fractures along a rounded edge of a side scraper (10x).



Figure 35. UA76-0302: Uneven oblique and perpendicular feather and snap fractures (10x).



Figure 36. UA76-0600: Two clusters of hinge and snap fractures on a utilized edge, obscured or oxidized residue (8x).



Figure 37. UA76-0656: Continuous perpendicular snap and hinge fractures on a convergent scraper (8x).



Figure 38. UA76-0656: Continuous perpendicular hinge fractures exhibiting utilization along a retouched edge of a convergent scraper (10x).



Figure 39. UA76-1361: Crushed and abraded edges along multi-directional hinge fractures on a bifacial obsidian knife, or possible projectile point fragment (10x).



Figure 40. UA76-1361: Possible hafting location at a notch on right margin (10x).



Figure 41. UA76-1361: Opposite (right) margin of possible hafting location where a sample was cut for obsidian hydration (10x).



Figure 42. UA76-2474: Distal margin of an end side scraper (10x).

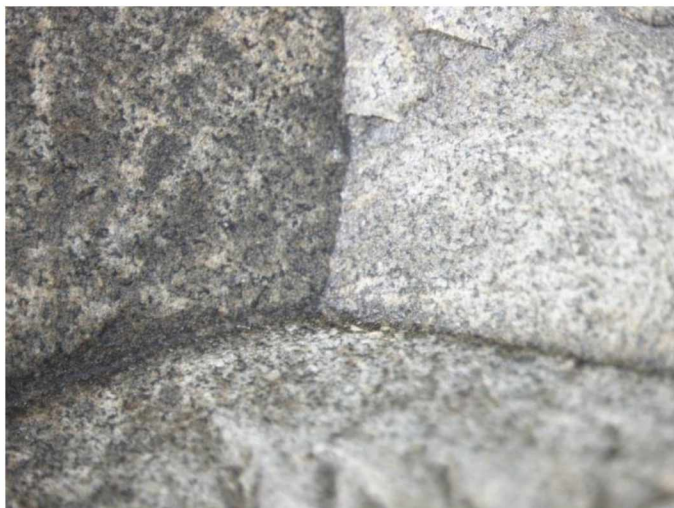


Figure 43. UA76-360: Surface sheen formed on dorsal ridge of tool (15x).



Figure 44. UA76-4035: Retouched edge with small uniface non overlapping isolated hinge and small snap fractures (8x).



Figure 45. UA76-4047: Uniface perpendicular overlapping hinge fractures indicative of scraping activity on a discoidal bifacial scraper (10x).



Figure 46. UA76-4067: Continuous clusters of scalar feather fractures (10x).



Figure 47. UA76-4067: Small, continuous to isolated uniaxial snaps and chips fractures along a roughened edge of a pointed scraper (10x).

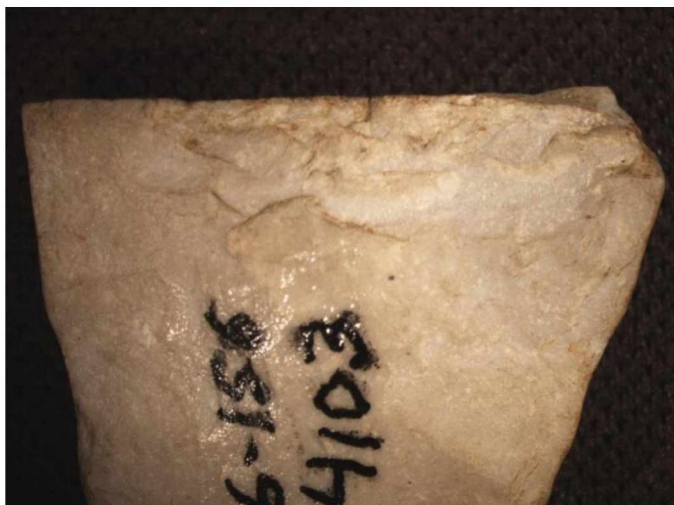


Figure 48. UA76-4103: Distal margin of a small spatulate knife base showing break location (8x).

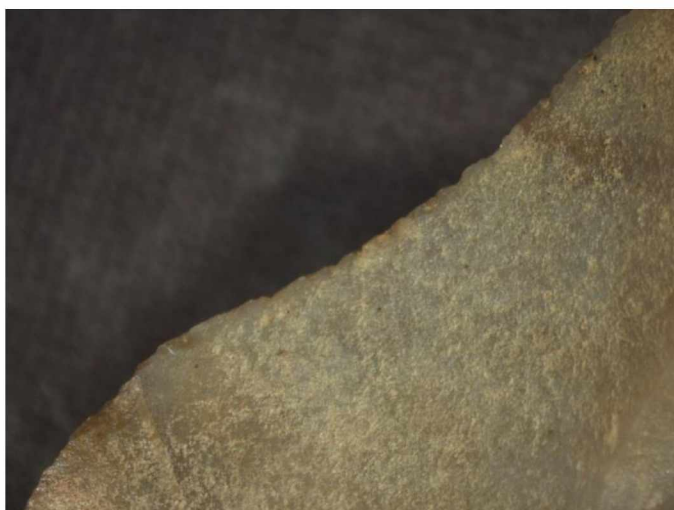


Figure 49. UA76-4203: Roughened edge of a utilized biface fragment (8x).



Figure 50. UA76-4370: Continuous perpendicular hinge and feather fractures on the margin of an end scraper (10x).



Figure 51. UA76-4384: Continuous unifacial perpendicular hinge fractures along the retouched edges of a scraper (8x).



Figure 52. UA76-4384: Continuous, non-overlapping perpendicular hinge, feather, and snap fractures along an unmodified edge of a scraper (10x).

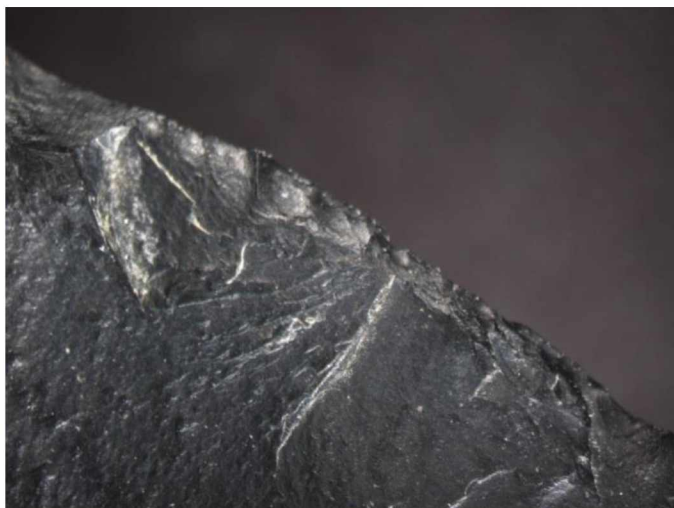


Figure 53. UA76-4400: Unifacial continuous oblique feather, hinge, and small step fractures on a knife edge (10x).



Figure 54. UA76-4475: Hafted area of a projectile point base showing rounded flake scar patterns (right margin) (10x).



Figure 55. UA76-4616: Distal margin of an end scraper with snap and hinge fractures (dorsal) (8x).



Figure 56: UA76-4616: Distal margin of an end scraper (ventral) (8x).



Figure 57. UA76-4632: Unifacial perpendicular continuous hinge and snap fractures on the left lateral margin of a pointed side scraper (8x).



Figure 58. UA76-4632: Distal margin exhibiting a hinge fracture at the tip of a pointed side scraper (ventral view) (8x).



Figure 59. UA76-5265: Edge of a biface tip fragment exhibiting flake scar erosion and surface sheen (10x)



Figure 60. UA77-0210: Left proximal view showing the rounded edge in hafted area of a knife (10x).

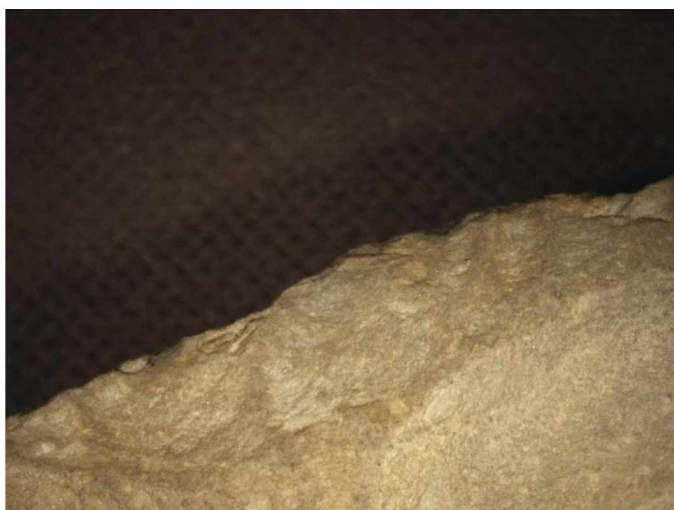


Figure 61. UA77-0213: Clusters of eroded step and hinge fractures on the left distal margin of a hafted bifacial knife (10x).



Figure 62. UA77-0213: Very well-rounded edge in the hafted area of a biface (20x).

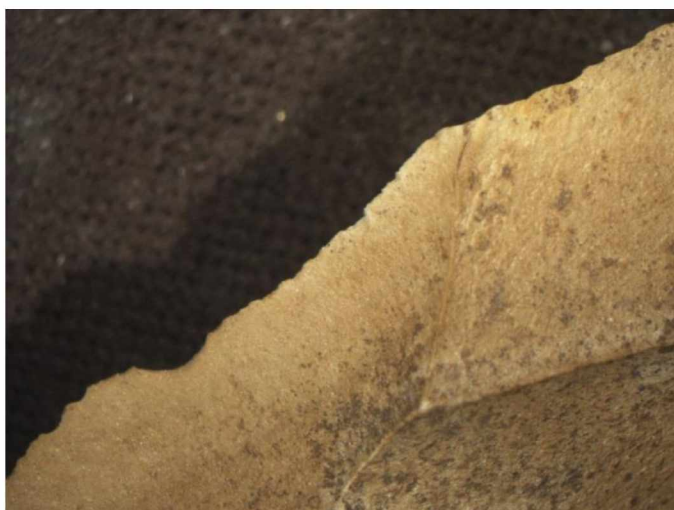


Figure 63. UA77-0367: Uneven snap fractures along an unmodified edge of a blade (8x).



Figure 64. UA77-0930a: Unifacial non-overlapping perpendicular hinge and step fractures on a distal biface fragment (8x).



Figure 65. UA77-0930: Typical edge along a miscellaneous biface, not utilized (10x).

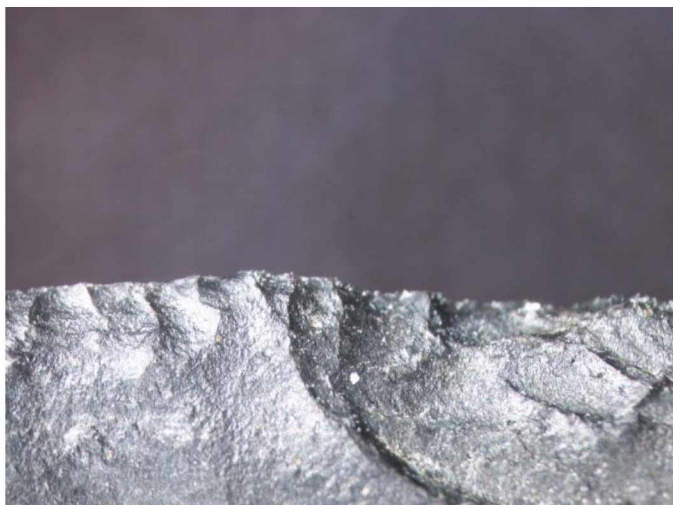


Figure 66. UA77-1591: Continuous, perpendicular, hinge, and step fractures (10x).



Figure 67. UA77-1591: Utilized edge exhibiting small hinge and step fractures (20x).



Figure 68. UA77-1728: Hinge fractures at the tip of a hafted biface (20x).



Figure 69. UA77-1847: Clusters of perpendicular to oblique hinge and step fractures on the proximal margin of a small spatulate knife base (20x).



Figure 70. UA77-1847: Very small feather fracture on a biface fragment (60x).



Figure 71. UA77-1847: Perpendicular step fractures (30x).



Figure 72. UA77-1879: Possible red “ochre-like” residue at left and right hafted areas of a triangular bifacial knife, possible point from C2 (10x).

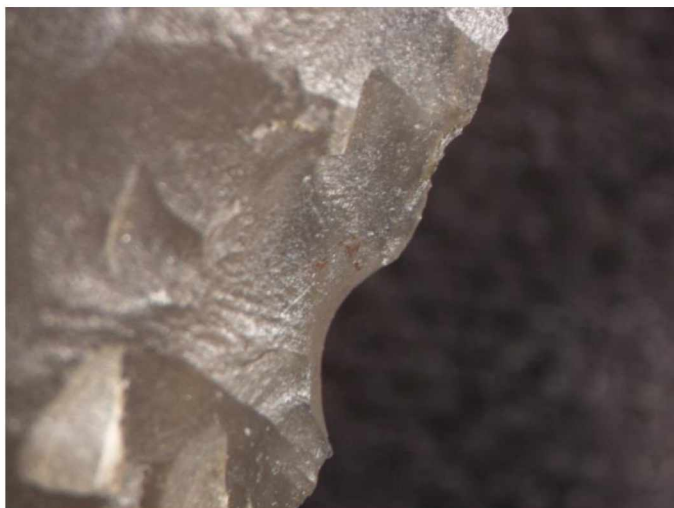


Figure 73. UA77-1879: Reddish residue with an ochre-like color appearing in a rounded flake scar, possibly indicating hafting location (20x).



Figure 74. UA77-1902: Continuous perpendicular hinge and feather fractures on the edge of a miscellaneous biface (10x).



Figure 75. UA77-1999: Oxidized surface showing the rounded edges of a biface with white residue along the edge (10x).



Figure 76. UA77-2318: Very well-rounded edge of a biface fragment (10x).



Figure 77. UA77-2040: Bifacial oblique crushed, hinge, and step fractures on a biface fragment (8x).



Figure 78. UA77-2384: Continuous perpendicular to oblique feather and hinge fractures on a biface fragment (30x).

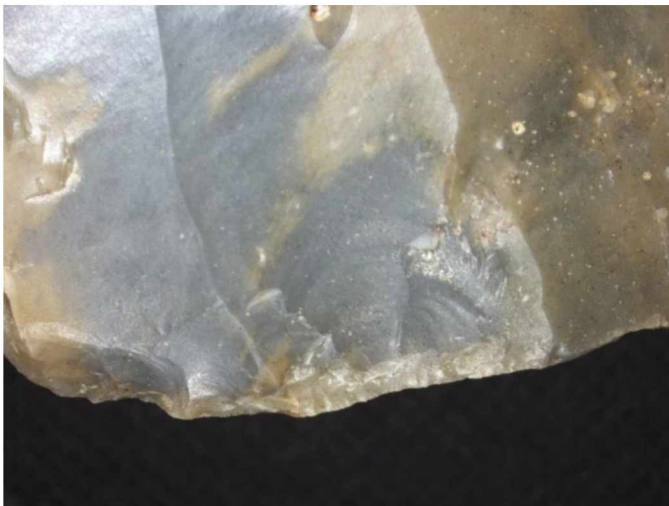


Figure 79. UA77-2385: Continuous perpendicular hinge fractures on the proximal margin of a biface fragment (10x).



Figure 80. UA77-4547: Continuous perpendicular unifacial hinge fractures on an end scraper (10x).



Figure 81. UA77-2293: Very small left lateral biface fragment, not utilized, (15x).

APPENDIX C: INFORMAL TOOLS



Figure 82. UA76-1614: Continuous perpendicular snap and hinge fractures on a lateral margin of a flake (8x).



Figure 83. UA76-4629: Right margin of a utilized flake (10x).

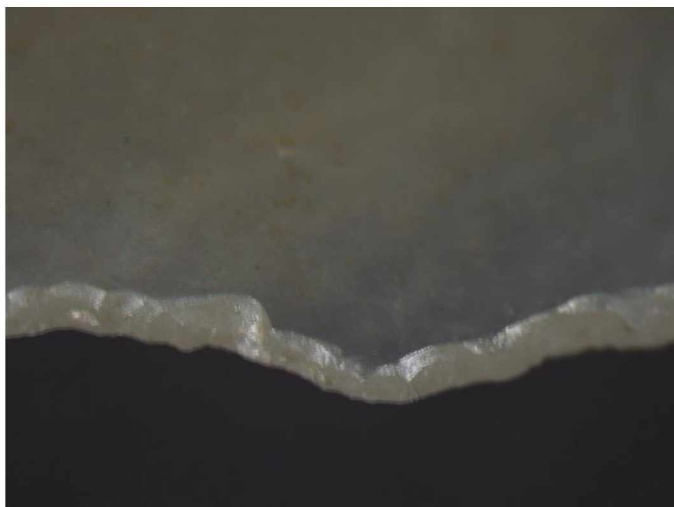


Figure 84. UA76-4629: Bifacial continuous overlapping snap and hinge fractures on a utilized flake (20x).



Figure 85. UA76-4278: Bifacial perpendicular continuous hinge fractures on the crushed edge of a flake knife, (30x).

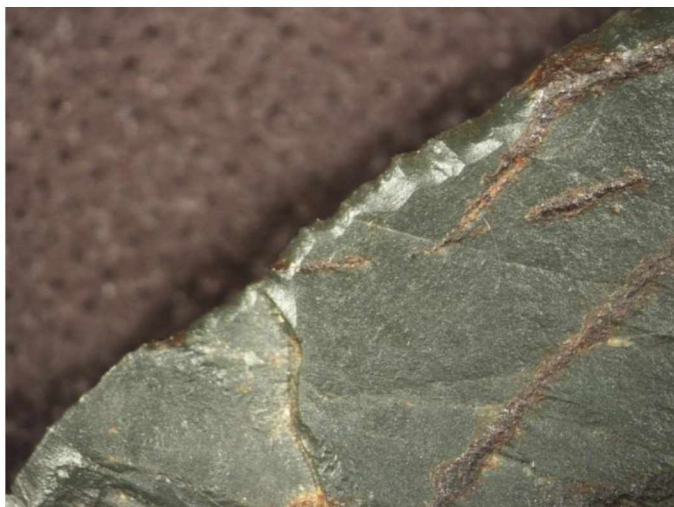


Figure 86. UA76-3400: Bifacial continuous perpendicular and oblique hinge and snap fractures (15x).

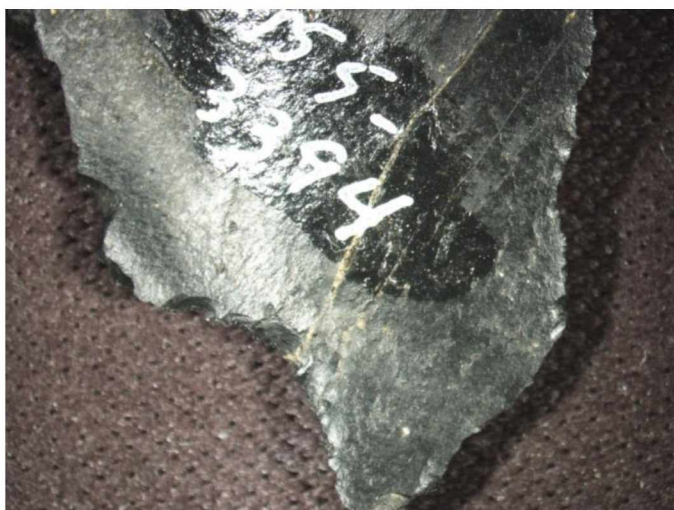


Figure 87. UA76-3394: Distal margin of a utilized flake showing continuous to non-overlapping step fractures (8x).



Figure 88. UA76-3394: Continuous snap and hinge fractures along a crushed edges on element 1(10x).

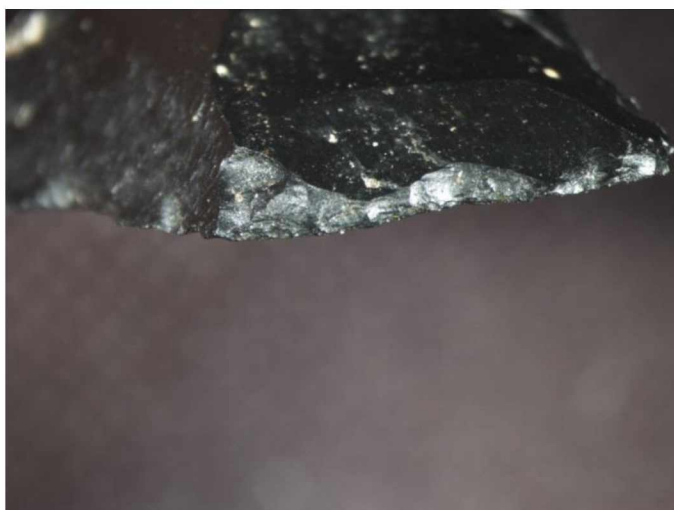


Figure 89. UA76-3394: Continuous perpendicular hinge and isolated snap fractures on a second utilized element of a flake tool (15x).



Figure 90. UA74-0004: Retouched flake exhibiting continuous perpendicular hinge and occasional feather fractures (15x).

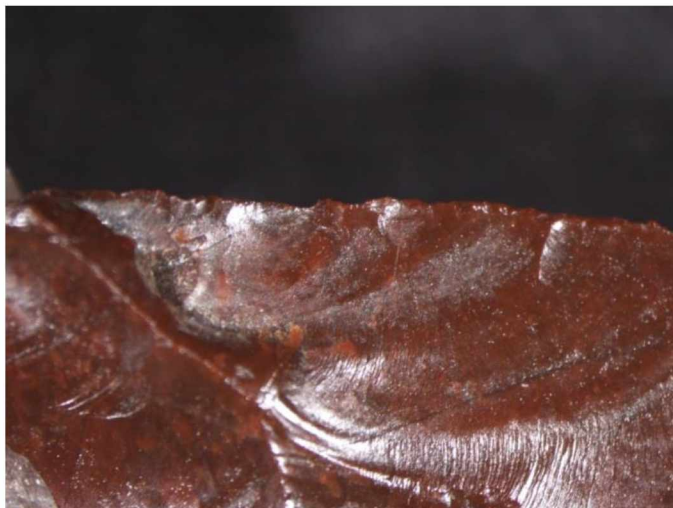


Figure 91. UA77-1433: Continuous bifacial hinge and feather fractures on a flake knife edge (15x).

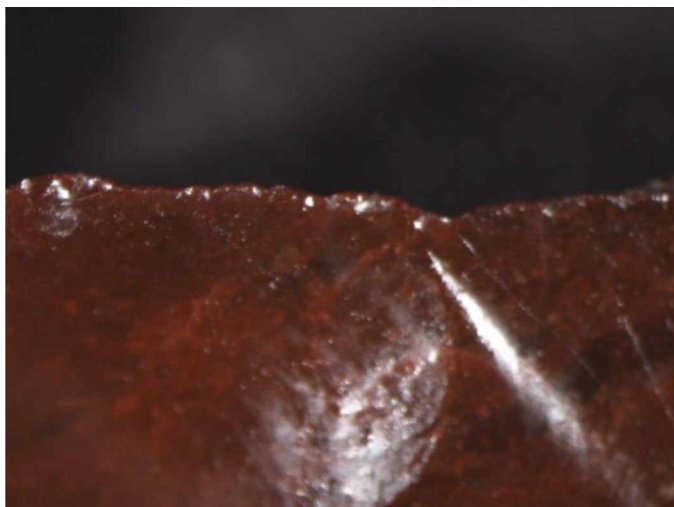


Figure 92. UA77-1433: Ventral view of a flake knife edge (15x).



Figure 93. UA76-4039: Continuous unifacial hinge and step fractures on a retouched flake (15x).



Figure 94. UA76-0493: Continuous perpendicular and ground hinge fractures, element 1, (15x).



Figure 95. UA76-0493: Continuous non-overlapping hinge fractures on the right proximal margin, element 2, (10x).

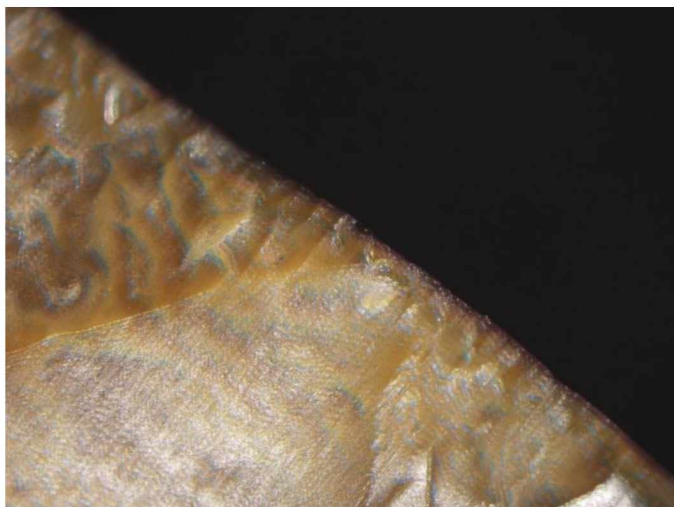


Figure 96. UA77-2386: Continuous perpendicular hinge fractures on a flake scraper (15x).



Figure 97. UA76-1305: Continuous non-overlapping perpendicular hinge fractures on the utilized element of a retouched flake (20x).



Figure 98. UA76-1305: Continuous perpendicular hinge and snap fractures on a second utilized element (15x).



Figure 99. UA77-2386: Continuous unifacial perpendicular hinge fractures on a chert flake scraper (10x).

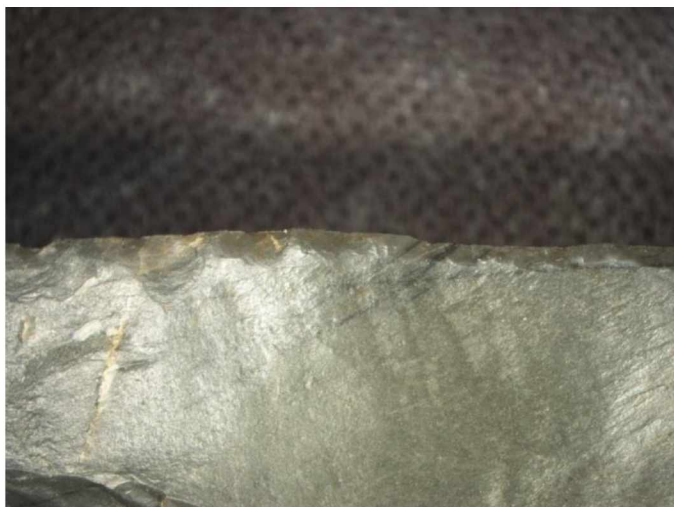


Figure 100. UA77-3209: Dorsal view of continuous perpendicular hinge and step fractures on a chert flake scraper (10x).

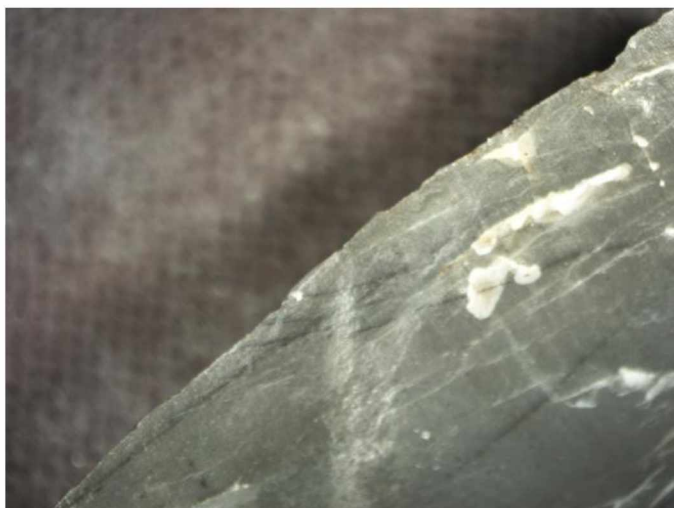


Figure 101. UA77-3209: Ventral view of a roughened margin beneath the utilized element of a chert flake scraper (10x).



Figure 102. UA73-0010: Close perpendicular hinge fractures, note oxidized residue, (15x).



Figure 103. UA76-4090: Continuous perpendicular hinge fractures before terminating at a large snap (10x).



Figure 104. UA7-1371: Close unifacial hinge and snap fractures on the distal right margin of a perforator (20x).



Figure 105. UA77-1371: Unifacial close, none-overlapping, snap, hinge, and feather fractures on the distal left margin of a flake used as a perforator (20x).



Figure 106. UA74-0287: Continuous unifacial but slightly eroded edge damage on a flake fragment (15x).



Figure 107. UA76-5606: Continuous perpendicular hinge fractures on the retouched edge of a flake (10x).



Figure 108. UA76-4631: Continuous uniface perpendicular hinge and snap fractures (10x).

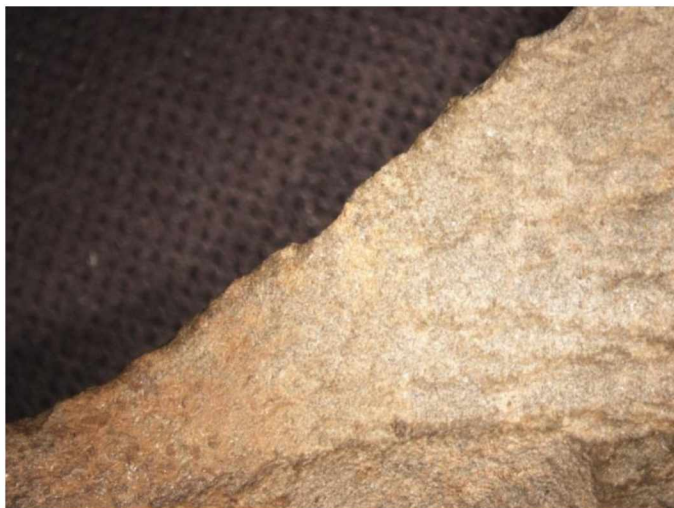


Figure 109. UA77-0483: Bifacial close non-overlapping hinge and isolated snap fractures on a blade-like flake (10x).

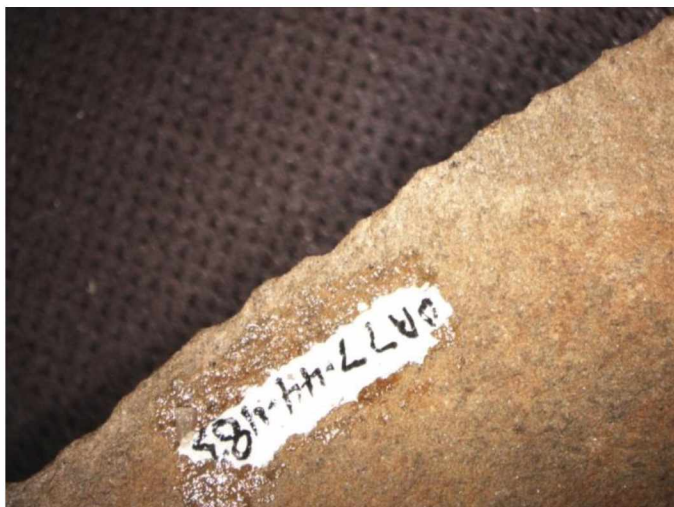


Figure 110. UA77-0483: Ventral view of a blade-like flake (8x).

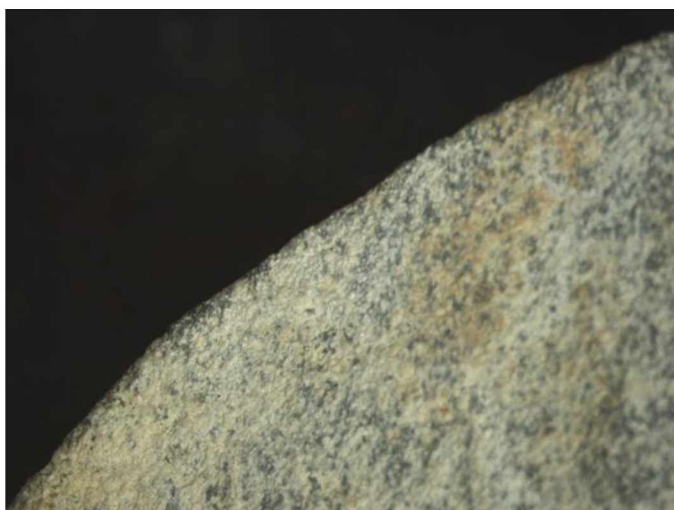


Figure 111. UA77-0148: Typical margin of a large non-utilized flake (10x).



Figure 112. UA73-0009: Blade fragment with a roughened edge, exhibiting isolated hinge fractures (8x).



Figure 113. UA77-3726: Retouched edge of a flake, not utilized (8x).



Figure 114. UA76-4632: Distal margin of a utilized flake (10x).

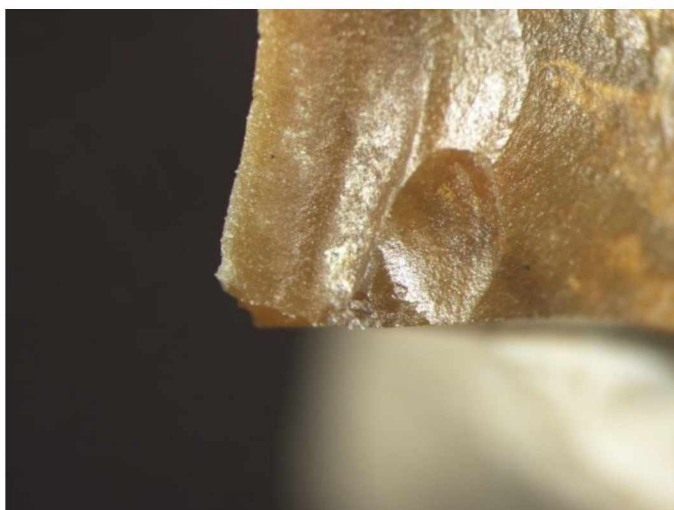


Figure 115. UA76-0847: Small overlapping perpendicular hinge fractures on a utilized burinated edge (20x).

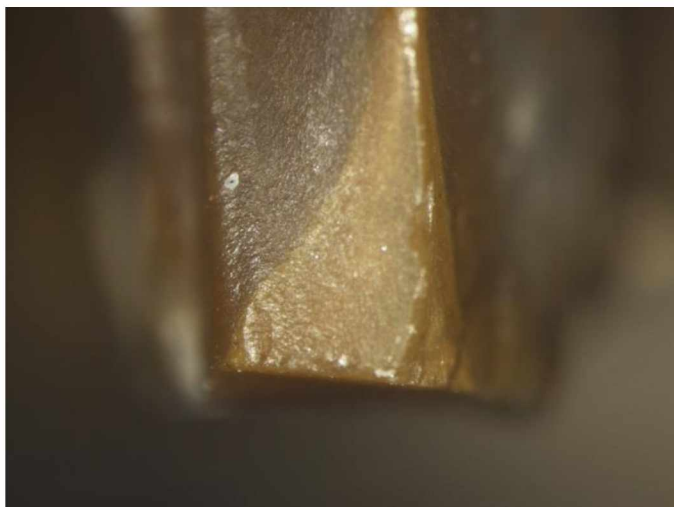


Figure 116. UA76-0775: Perpendicular hinge fractures on a burinated edge, element 1 (20x).



Figure 117. UA76-0775: Unifacial continuous perpendicular hinge fractures on the lateral margin of a flake burin, element 2 (10x).



Figure 118. UA76-2346: Overlapping, perpendicular hinge fractures on a burinated edge of a core tablet (20x).

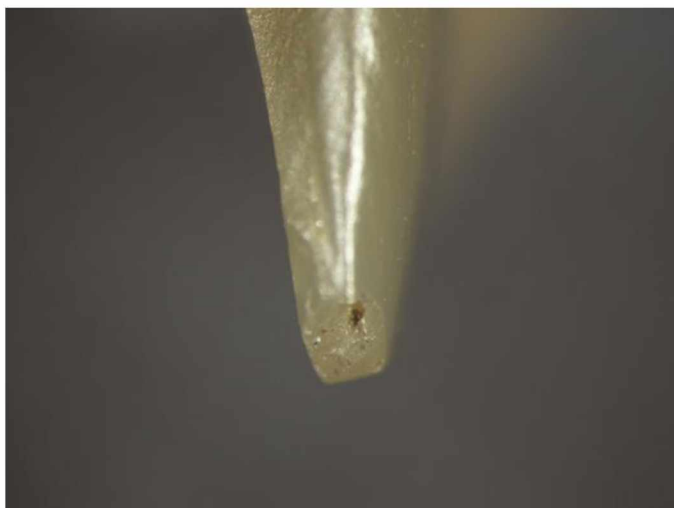


Figure 119. UA76-2490: Unutilized burin edge on a flake (20x).

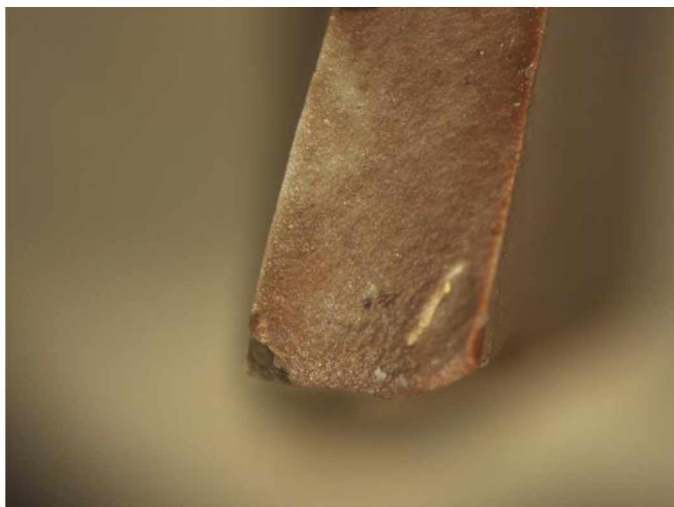


Figure 120. UA77-0370: Isolated continuous clusters of perpendicular hinge fractures on the burinated edge of a flake (20x).



Figure 121. UA76-2125: Burinated edge of a black chert flake, not utilized (20x).

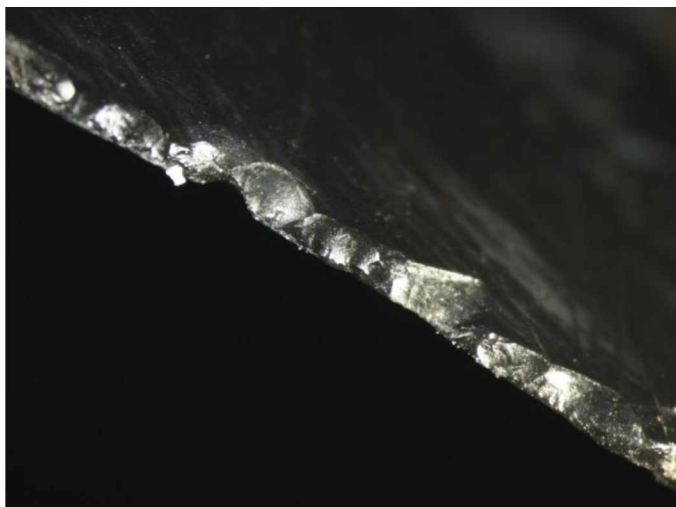


Figure 122. UA76-2125: Continuous unifacial step and hinge fractures on the margin of a burinated flake (20x).



Figure 123. UA76-2030: Continuous step and hinge fractures on a ground edge of a burin (20x).



Figure 124. UA76-2023: Overlapping, perpendicular step fractures on a burinated edge, element 1 (20x).



Figure 125. UA76-2023: Tangential snap and hinge fractures on the left margin of a burinated flake, element 2 (15x).



Figure 126. UA77-2242: Burinated edge, not utilized (20x).



Figure 127. UA77-2986: Burinated edge (20x).

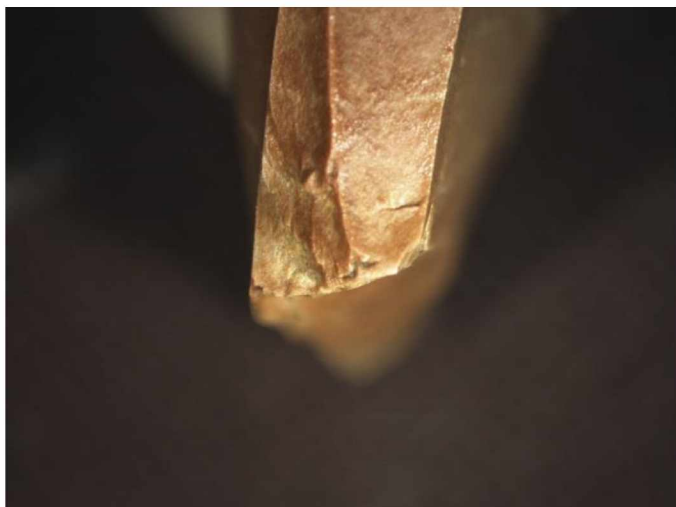


Figure 128. UA76-5496: Burinated edge showing snap fractures on one margin and more obliquely oriented snap and hinge fractures on the opposite margin (15x).



Figure 129. UA76-0845: Burin edge of a flake, not utilized (15x).

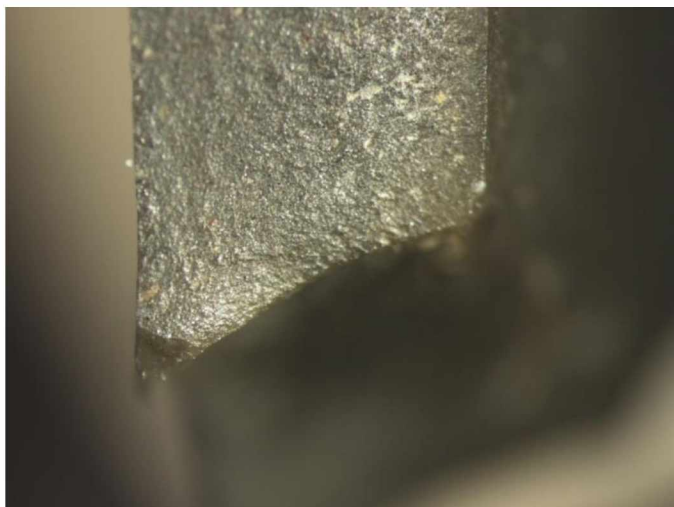


Figure 130. UA77-1570: Burinated edge of a flake, not utilized (20x).



Figure 131. UA77-0712: Burinated edge of a flake, not utilized (20x).



Figure 132. UA76-2016: Unifacial continuous hinge and step fractures leading to a burinated edge (15x).

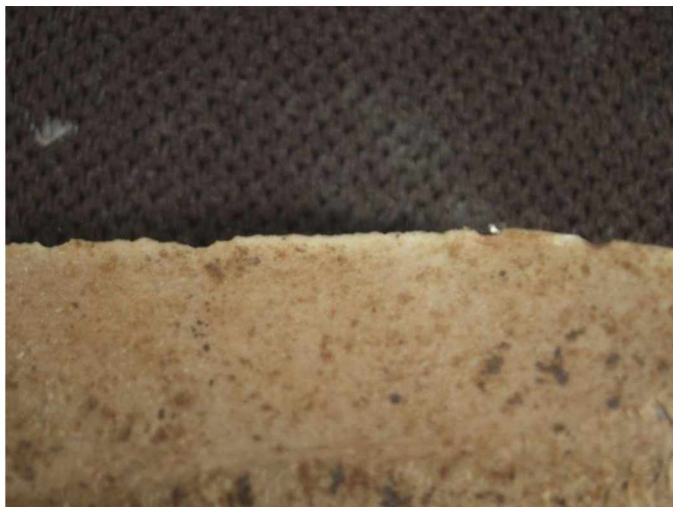


Figure 133. UA76-3249: Roughened edge exhibiting isolated and continuous snap fractures on a burinated flake 10x).



Figure 134. UA77-1570: Continuous unifacial hinge fractures on the distal margin of a burinated flake (20x).



Figure 135. UA77-0712: Continuous oblique hinge and step fractures on the left lateral margin of a burinated flake (8x).



Figure 136. UA76-3642: Bifacial continuous oblique snap fractures on a burinated flake (8x).



Figure 137. UA76-2016: View of scraper wear on a dihedral burin, note eroded flake scar patterns (20x).



Figure 138. UA76-1889: Continuous perpendicular hinge fractures on a burinated flake (15x).

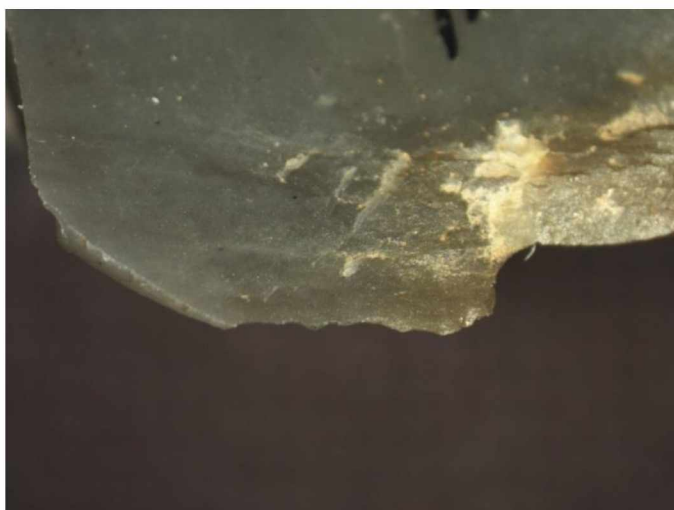


Figure 139. UA76-1889: Ventral view of utilized margin of a burinated flake (15x).

APPENDIX D: RESIDUES AND TAPHONOMIC VARIABLES

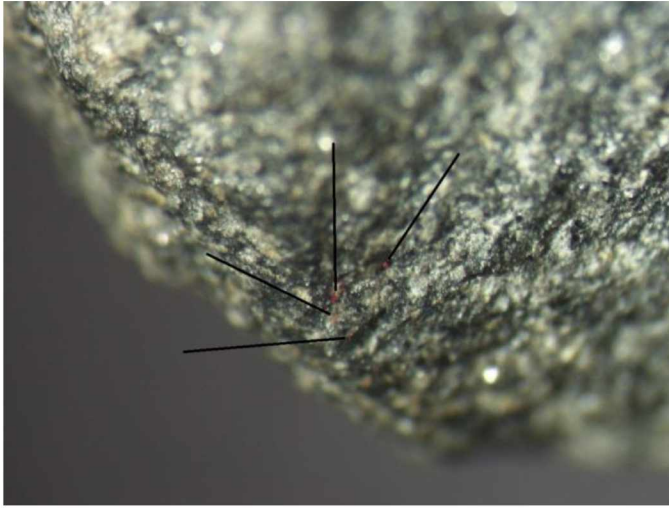


Figure 140. UA77-0005: Bright reddish ochre-like color on the edge of a biface (40x).



Figure 141. UA76-0149: Charcoal and ash near a crack on cortical material of a rhyolite flake (10x).



Figure 142. UA77-2659: View of area removed by possible frost fracture on a utilized edge of a tool (dorsal view) (8x).



Figure 143. UA77-22386: Micropits on the surface of a chert flake (20x).

Possible Carbonates



Figure 144. UA77-0304: White carbonate-like residue on the edge of a sampled tool (10x).



Figure 145. UA77-0929: Possible calcium carbonate on the tip of a biface (10x).



Figure 146. UA77-0929: Rounded dorsal flake scar pattern and surface sheen occurring with possible calcium carbonate on the dorsal surface of a biface (8x).



Figure 147. UA77-1593: White residue on the surface of an unfinished biface (20x).



Figure 148. UA76-4090: White residue on edge of a tool (15x).



Figure 149. UA76-0026: White residue on the edge of a blade (10x).



Figure 150. UA77-0148: White residue built upon the surface in association with surface sheen (10x).



Figure 151. UA76-4631: White patina on a flake (10x).



Figure 152. UA77-2386: White patina on the surface of a flake scraper (10x).



Figure 153. UA77-3884: Possible carbonate on the surface of a biface (10x).

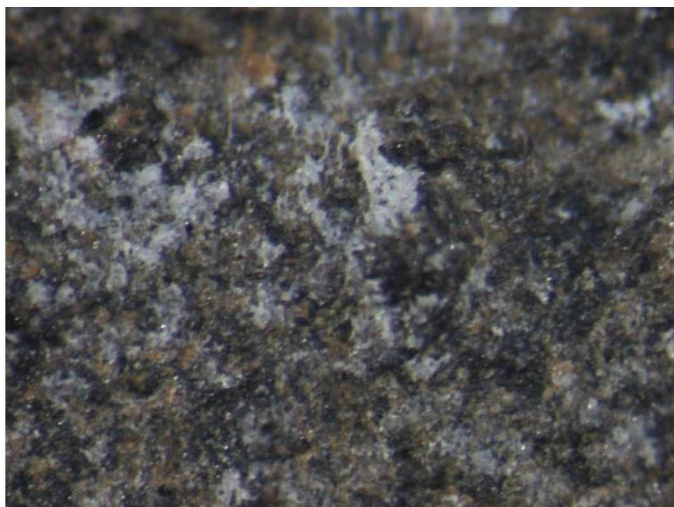


Figure 154. UA74-0068: Close-up of sugary white residue on the surface of a tool (60x).



Figure 155. UA74-0081: White sugary residue on tool surface (60x).



Figure 156. UA77-4047: Possible calcium carbonate (30x).

Possible Lichens



Figure 157. UA76-4631: Orange colored lichen on surface of a refit flake (10x).



Figure 158. UA77-0269: Cream colored residue near a hinge fracture on the distal margin of a biface (8x).



Figure 159. UA77-2013: White patina on the surface of a convergent scraper (20x).



Figure 160. White residue on the surface of a bifacially worked cobble (10x).



Figure 161. UA76-0259: Oxidized residue on the surface of a gray rhyolite flake (8x).



Figure 162. UA74-0199: Oxidized residue observable on the margin of a bifacial knife (view to left) (10x).



Figure 163. UA76-3642: Oxidized residue on the surface of a burinated flake (15x).

Surface Sheen



Figure 164. UA74-0081: Surface sheen (8x).



Figure 165. UA77-2986: Surface sheen on a gray basal burinated flake (30x).



Figure 166. UA74-0004: Surface sheen becoming more visible on a black chert side scraper (30x).



Figure 167. UA77-2383: Rounded, possibly hafted area of a projectile point base, not dark sheen along the edges and surface (8x).



Figure 168. UA77-4331: Surface sheen along the edge of a side and end scraper (10x).

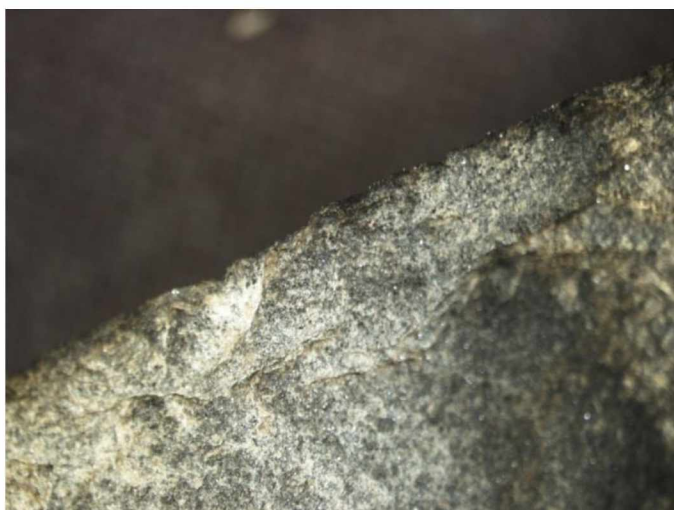


Figure 169. UA77-0269: Eroded flake scar patterns on the lateral margin of a biface (15x).



Figure 170. UA77-4026: Surface sheen on an early stage biface (10x).



Figure 171. UA77-1779: Surface sheen on a burinated flake (10x).



Figure 172. UA77-0148: Surface sheen on the dorsal ridge of a large quartzite flake (20x).



Figure 173. UA76-4090: Surface sheen and possible oxidation on a basalt tool (8x).

Oxidized Materials



Figure 174. UA76-4127: Oxidized residue, possible pitch, on a biface fragment (8x).



Figure 175. UA77-3726: Possible oxidized cortical material remaining on the surface of a rhyolite flake (8x).



Figure 176. UA77-0454: Burned and eroded retouch flake scar patterns on a biface fragment; note the white residue along the edge (8x).



Figure 177. UA77-0745: Oxidized cortical material and non-oxidized subcortical material on a miscellaneous biface (10x).



Figure 178. UA77-2318: Oxidized margin at break location of a basalt biface fragment (8x).



Figure 179. UA77-2659: Possible soil sheen and oxidation on the surface of a utilized flake (20x).